CLOTH DESIGN GENERATOR USING MACHINE LEARNING

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College : *BGS Institute of Technology, Mandya*
Branch : *Department of Artificial Intelligence and Machine*
Guide(s) : *Ms. Bindu K N*
Mrs. Afsha Firdose
Student(s) : *Ms. Vyshali PL*
Ms. Spandana R
Ms. Varshitha BC
Ms. Veena GL

Keywords:

Stable diffusion model, machine learning based offline learning, hence cost effective, serves well in low network connections, tracks history, blend it for personalisation, focuses Indian aesthetics, modernizing of indian art designs, focused specially for Indian fabric, silk and cotton, uplifting Indian farmers, finally ecology too.

Introduction:

This project focuses on developing an offline cloth design generator using a Stable Diffusion model that is fine-tuned for Indian aesthetics. Stable Diffusion is a machine learning technique capable of generating high-quality images from textual inputs. In this work, the model is trained using datasets of traditional Indian silk and cotton textile patterns, enabling it to produce culturally relevant and visually appealing designs.

The main objective of the system is to modernize traditional Indian textile designs while preserving their cultural identity. By combining traditional motifs with modern design elements, the system helps create designs that are suitable for both local and global markets. This ensures that Indian textile heritage remains relevant in the evolving fashion industry.

A key feature of this project is its offline functionality, which eliminates the need for high- speed internet or cloud-based services. This makes the system cost-effective and accessible to rural weavers and farmers who may have limited connectivity. Additionally, the system includes a design history feature that allows personalization by remembering previous designs and user preferences.

The concept of a “Digital Loom” enables users to generate and visualize designs digitally before actual production, reducing material wastage and promoting eco-friendly practices.

Objectives:

1. **To build an offline Stable Diffusion model** for cost-effective design in low-connectivity areas.
2. **To modernize Indian aesthetics** by fine-tuning the model on traditional silk and cotton motifs.
3. **To implement design history blending** for personalized, heritage-inspired fashion creation.
4. **To promote eco-sustainability** by reducing material waste through digital-first prototyping.

Methodology:

The project follows a modular AI-lifecycle approach:

1. **Curation:**

   In this stage, a dataset of Indian textile designs is collected, focusing mainly on silk and cotton fabrics. The dataset includes images along with descriptive metadata such as pattern type, color and style. This helps the model understand the characteristics of traditional Indian designs.

2. **Optimization:**

   The collected dataset is used to fine-tune the Stable Diffusion model using techniques like LoRA (Low-Rank Adaptation). This process enables the model to learn and generate designs specific to Indian art styles while reducing computational requirements.

3. **Deployment:**

   After training, the model is optimized and quantized to reduce its size and make it suitable for offline execution on local systems. A FastAPI backend is used to handle model operations efficiently, allowing users to generate designs without requiring internet connectivity.

4. **Interface:**

   A user-friendly web interface is developed using Bootstrap. This interface allows users to generate designs by entering text descriptions or providing sketch inputs. It ensures easy interaction, even for non-technical users such as rural artisans.

5. **Validation:**

   The performance of the model is evaluated using standard metrics such as FID (Fréchet Inception Distance) to measure image quality and realism, and CLIP scores to assess how well the generated images match the input text. These metrics ensure that the system produces accurate and high-quality designs

Result and Conclusion:

In conclusion, the project successfully develops a localized artificial intelligence tool designed to support and empower Indian artisans. By integrating Stable Diffusion technology with traditional textile craftsmanship, the system is capable of generating innovative and culturally rich fabric designs. This combination of modern AI techniques with traditional knowledge helps in preserving the uniqueness of Indian textile heritage while adapting it to current design trends.

The system provides a cost-effective and offline design solution, making it highly accessible to rural weavers and farmers who may have limited access to internet and advanced resources. Additionally, the use of digital design generation eliminates the need for repeated physical sampling, thereby promoting a zero-waste approach and supporting environmentally sustainable practices.

Furthermore, the project contributes to the economic upliftment of rural communities by

enhancing productivity and enabling artisans to create market-relevant designs more efficiently. By bridging the gap between traditional craftsmanship and modern digital technology, the system ensures that Indian textile traditions continue to grow and remain competitive in today's global and digital economy.

Project Outcome & Industry Relevance:

This project demonstrates strong relevance in the textile and fashion industry by integrating advanced machine learning techniques with traditional design processes. In the era of digital transformation, the system enables rapid and automated cloth design generation, significantly reducing the time and effort required compared to manual methods. The proposed solution supports customization by allowing users to generate unique designs based on text inputs, making it highly adaptable to individual preferences and market trends. This capability is particularly valuable for designers and small-scale industries aiming to produce innovative and personalized products. The system can be effectively utilized by textile designers, fashion industries, rural weavers, artisans, and small-scale fabric manufacturers. It empowers rural communities by providing them with a cost-effective and easy-to-use design tool that does not depend on high-speed internet connectivity. Furthermore, the project aligns with national initiatives like "Make in India" by promoting local craftsmanship and enhancing the global competitiveness of Indian textile products. By enabling digital prototyping, the system reduces material wastage and supports sustainable production practices. Overall, it acts as a bridge between traditional textile heritage and modern technological advancements.

Working Model vs Simulation:

1. The project is implemented as a fully functional working model rather than just a theoretical simulation. It consists of a fine-tuned Stable Diffusion model that is capable of generating high-quality cloth designs based on user inputs. The backend of the system is developed using FastAPI, which efficiently handles **model** execution and user requests. A web-based user interface is created using Bootstrap to ensure simplicity and ease of use, even for non-technical users.
2. Unlike simulations that only demonstrate conceptual results, this working model produces real-time outputs, allowing users to input text descriptions or sketches and instantly visualize the generated designs. The offline functionality further enhances its practicality, making it deployable in rural and low-resource environments.

Project Outcomes and Learnings:

1. Through the development of this project, significant technical and practical knowledge has been gained. The team developed a strong understanding of generative artificial intelligence, particularly diffusion models such as Stable Diffusion, and their application in image generation tasks.
2. Hands-on experience was obtained in training and fine-tuning machine learning models using domain-specific datasets. The project also provided exposure to backend development using FastAPI and frontend design using Bootstrap, enabling the creation of a complete end-to-end system.
3. Additionally, the team learned to evaluate model performance using standard metrics such

as FID (Fréchet Inception Distance) and CLIP score, ensuring the quality and relevance of generated outputs.

4. Beyond technical skills, the project enhanced problem-solving abilities by addressing real-world challenges faced by the textile industry, especially in rural areas. It also improved teamwork, project management, and the ability to integrate interdisciplinary concepts from machine learning and traditional craftsmanship.

References:

1. J. Ho, A. Jain, and P. Abbeel,*"Denoising Diffusion Probabilistic Models,"* Advances in Neural Information Processing Systems, vol. 33, pp. 6840–6851, 2020.
2. R. Rombach, A. Blattmann, D. Lorenz, P. Esser, and B. Ommer,*"High-Resolution Image Synthesis with Latent Diffusion Models "*
3. Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), pp. 10684–10695, 2022.
4. T. Xiao, X. Liu, L. Luo, T. Ma, and L. Yu,*"FashionGAN:Clothing and Fashion Image Synthesis via GANs,"*IEEE Transactions on Multimedia, vol. 23, pp. 2545–2555, 2021.
5. R.Yingetal.,*"Multimodal Fashion Garment Synthesis by Latent Diffusion,"*arXivpreprint arXiv:2404.18591, 2023.
6. M. Mirza and S. Osindero,*"Conditional Generative Adversarial Nets,"* arXiv preprint arXiv:1411.1784, 2014.

Future Scope:

1. The project offers significant potential for future enhancements and real-world deployment. One major extension is the integration with IoT-enabled smart looms, where AI-generated designs can be directly converted into fabric production instructions, enabling automation in the weaving process.
2. Augmented Reality (AR) can be incorporated to provide real-time visualization of generated designs on garments, allowing users to preview the final product before manufacturing. This can greatly improve decision-making and reduce production errors.
3. Blockchain technology can be implemented to ensure transparency and traceability in textile production, helping verify the authenticity and origin of fabrics while promoting fair trade practices. The system can also be enhanced by adding multilingual voice-based input features, making it accessible to non-literate users and artisans who prefer regional languages.
4. Further improvements include expanding the dataset to include a wider variety of fabrics and global textile styles, enabling the system to cater to international markets. The project can also be developed into a mobile or desktop application for broader accessibility.
5. In addition, integrating advanced personalization techniques and recommendation systems can help users generate designs based on trends and preferences. These enhancements would make the system more intelligent, scalable, and impactful in the textile industry.