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College of Engineering and Computer Science

VIBELENS
Image-Based Music Recommendations System

TEAM MEMBERS

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INTRODUCTION

Background and context

- Social media platforms drive the need for creative, including **pairing music with images**.
- Manual music selection for images is **inconsistent and time-consuming**, leading to poor personalization.
- Most music recommendation work **relies on user behavior**; very little research connects visual input with music retrieval.

Problem statement and motivation

- Vibelens aims to **bridge the gap between visual content and musical aesthetics** by retrieve semantically relevant songs via vector similarity search.
- Our motivation is to create **a seamless and emotionally/ contextually personalized music experience** for social media users.

Objectives

- Enable users to upload an image and **receive 5–10 recommended songs.**
- Ensure that the **recommendations reflect the semantic content** and emotional tone of the image.
- **Build a scalable and responsive system** suitable for integration with social media or content creation platforms.

LITERATURE REVIEW – EXISTING SOLUTIONS

- Music recommendation systems typically **rely on collaborative filtering, audio-based features**, or metadata analysis (Schedl et al., 2018).
- Vision-Language Models (VLMs) can **convert images into semantically rich text** for downstream tasks (Ghosh et al., 2024)
- Vector databases (e.g., Pinecone) **enable fast semantic similarity search** in high-dimensional spaces (Jie et al., 2023).

Reference

[1] Akash Ghosh, Arkadeep Acharya, Sriparna Saha, Vinija Jain, and Aman Chadha. Exploring the frontier of vision-language models: A survey of current methodologies and future directions, 2024. URL https://arxiv.org/abs/2404.07214.

[2] James Jie, Jianguo Wang, Guoliang Li, and James Pan. Survey of Vector Database Management Systems. URL https: //arxiv.org/pdf/2310.14021.

[3] Markus Schedl, Hamed Zamani, Ching-Wei Chen, Yashar Deldjoo, and Mehdi Elahi. Current challenges and visions in music recommender systems research. International Journal of Multimedia Information Retrieval, 7(2):95–116, Apr 2018. doi: https://doi.org/10.1007/s13735-018-0154-2.

RESEARCH GAP & VIBELENS CONTRIBUTION

Research Gap

- Few studies connect visual content with musical context.
- Lack of integrated systems combining CV + NLP + music semantics for real-time recommendations.

Vibelens Contribution

- Uses image captioning + semantic vector matching to recommend emotionally aligned songs.
- Enrich user experience on multimedia platforms through image-to-music retrieval.

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METHODOLOGY – APPROACH & TECHNOLOGIES

Overall Approach

- Analyze image content using **vision-language models** (**ViT-GPT2**) to generate captions.
- Match **image-derived captions to song lyrics** using semantic similarity.

Core Technologies

- **Image Captioning:** ViT-GPT2
- **Text Embedding:** Sentence Transformers DistilUSE
- **Vector Search:** Pinecone vector database
- **Web Frameworks:** Flask (backend), Next.js (frontend)
- **Infrastructure:** Docker Swarm, Celery, Redis, PostgreSQL, MinIO, Kafka

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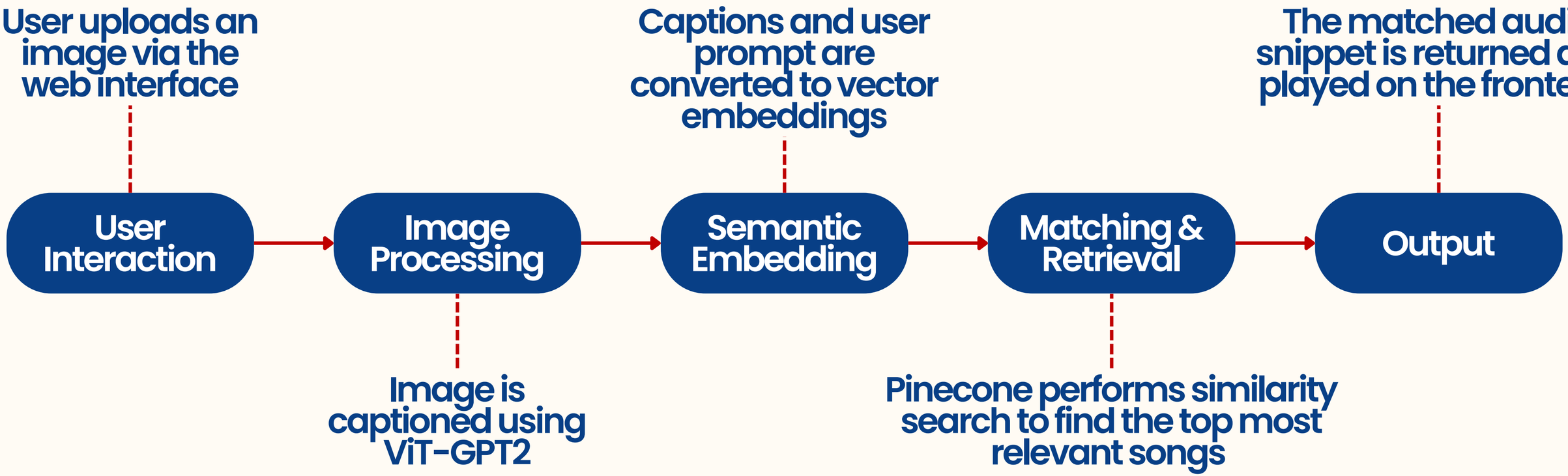
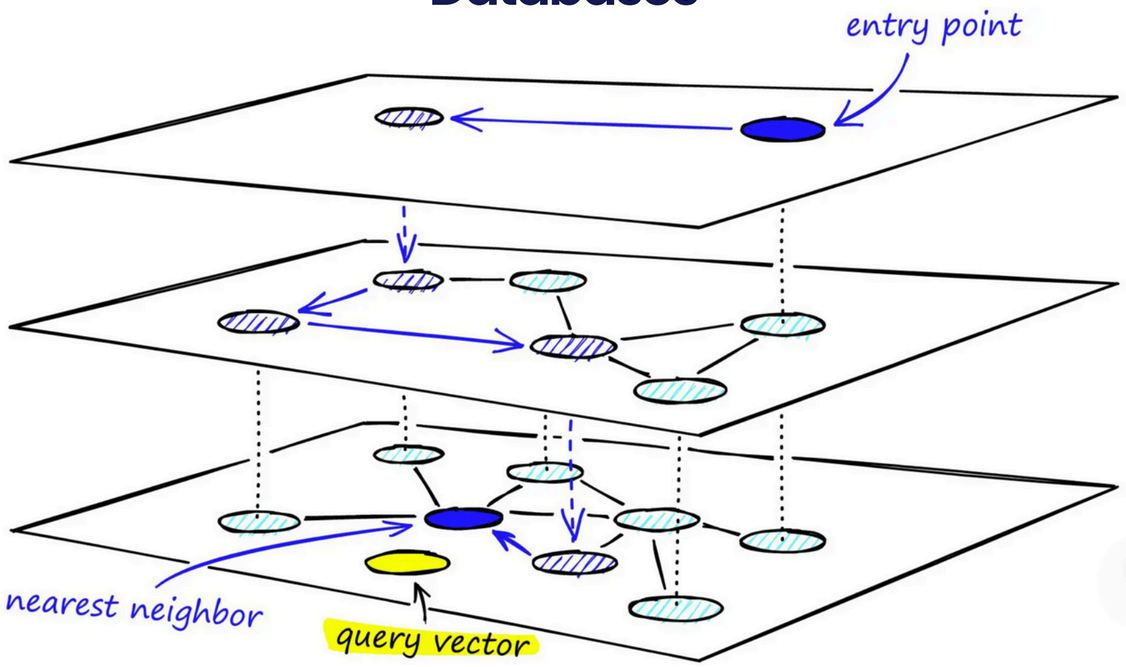
METHODOLOGY – SYSTEM WORKFLOW

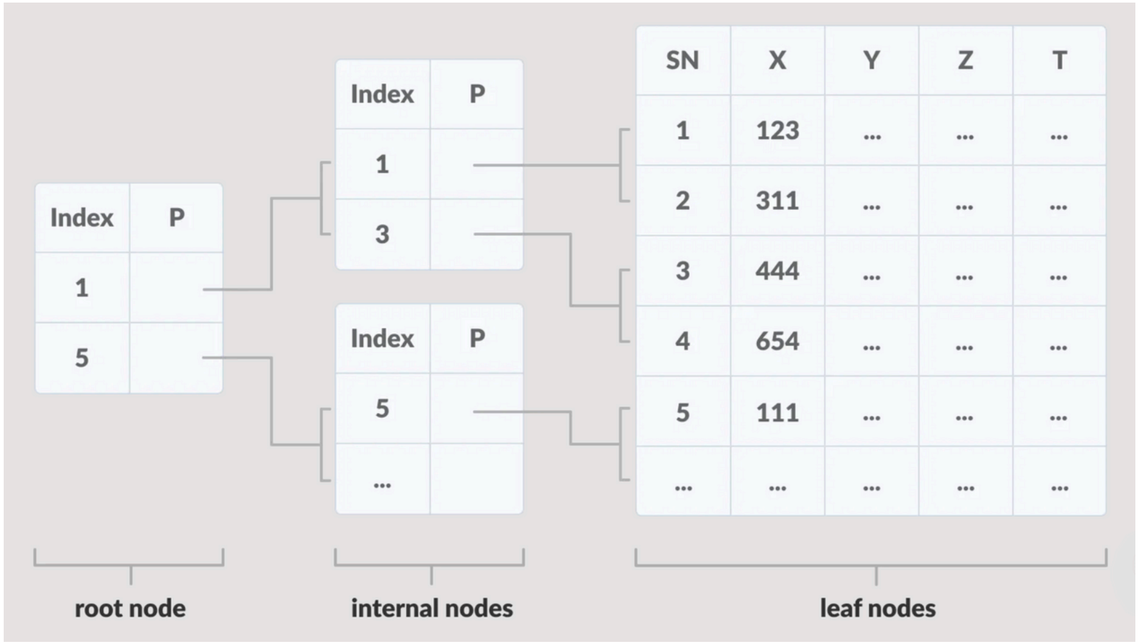


METHODOLOGY – ALGORITHMS & MODELS

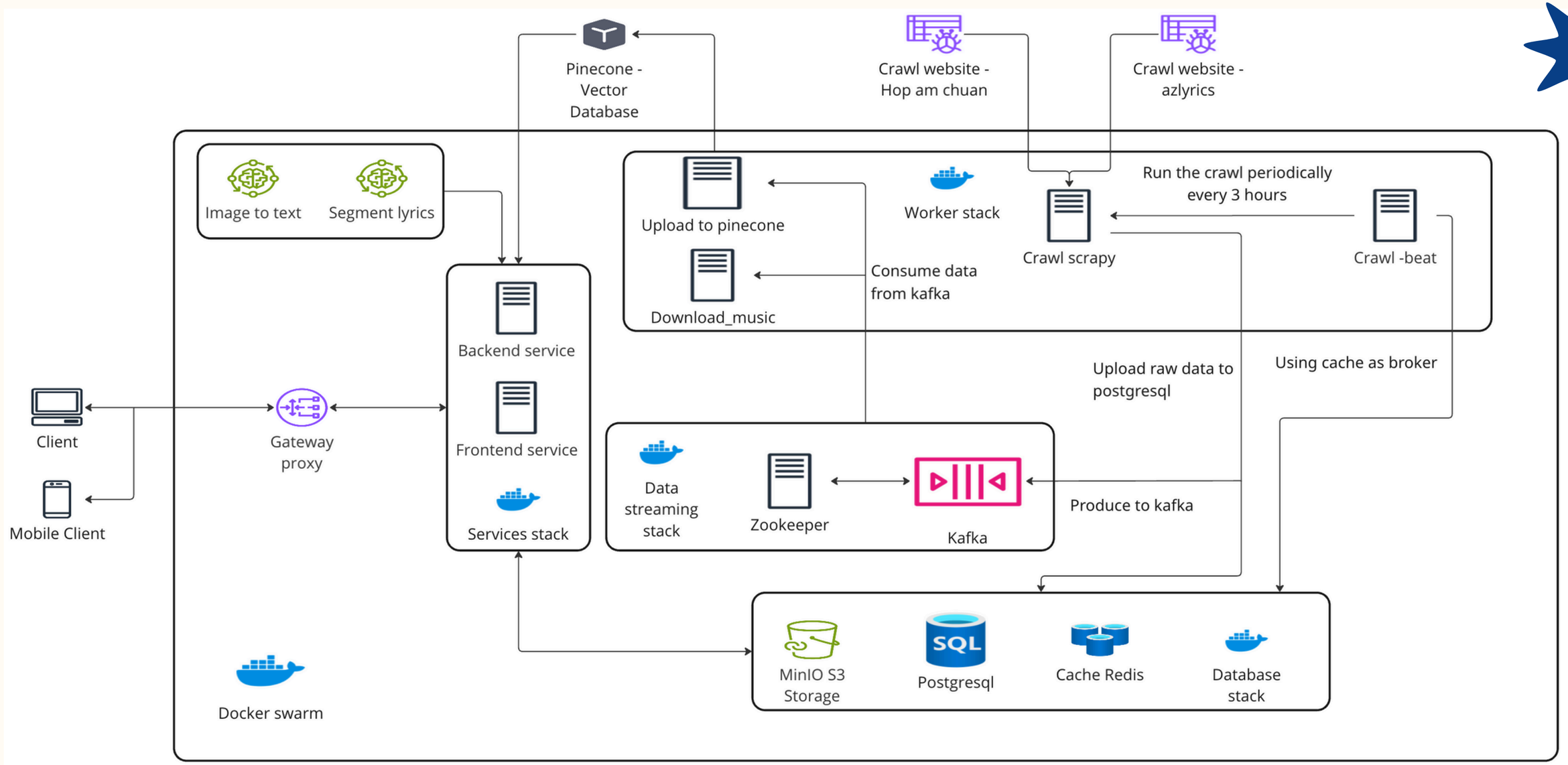
Hierarchical Navigable Small Worlds(HNSW) indexing in Vector Databases



B-trees & Hash Indexes



IMPLEMENTATION – SYSTEM ARCHITECTURE



IMPLEMENTATION

KEY MILESTONES

Week	Milestones
1 - 2	Project setup, team roles, initial research
3 - 4	Web crawler (Scrapy + Celery), MP3 & lyrics collection
5 - 6	Image captioning (ViT-GPT2), vector embedding & Pinecone integration
7 - 8	Frontend development (Next.js), backend integration (Flask)
9 - 10	Testing, bug fixes, and final presentation

CHALLENGES & SOLUTIONS

- **Infrastructure Limitations**

Running large models required more compute than available → Used local machines and optimized workflows with Docker Swarm.

- **Deployment Complexity**

Coordinating services (Flask, Redis, Kafka, Celery) caused integration bugs → Applied CI/CD automation and service orchestration.

- **Data Quality Issues**

Scraped lyrics often had formatting issues and mismatched audio → Implemented data cleaning and alignment scripts.

- **Model Adaptation**

No existing model was trained to link image content with music → Adapted general VLMs and bridged gap using semantic similarity.

RESULTS – VIDEO DEMO

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RESULTS – ANALYSIS

Final Outputs & Key Findings

- A **functional web-based system** that recommends emotionally relevant song segments from user-uploaded images.
- **Successfully integrated image captioning (ViT-GPT2), semantic matching via Pinecone**, and an end-to-end music retrieval pipeline.
- Developed a scalable backend using Flask, Kafka, Redis, and Docker Swarm; frontend built with Next.js.
- **Collected and processed a curated dataset of lyrics and MP3 files**, segmented and cleaned for precise recommendation.

Comparison with Expectations

Expectations

- Accurate, fast, personalized music recommendations.
- Full-stack deployment with modular components.
- Use pretrained model specific to music-visual matching.

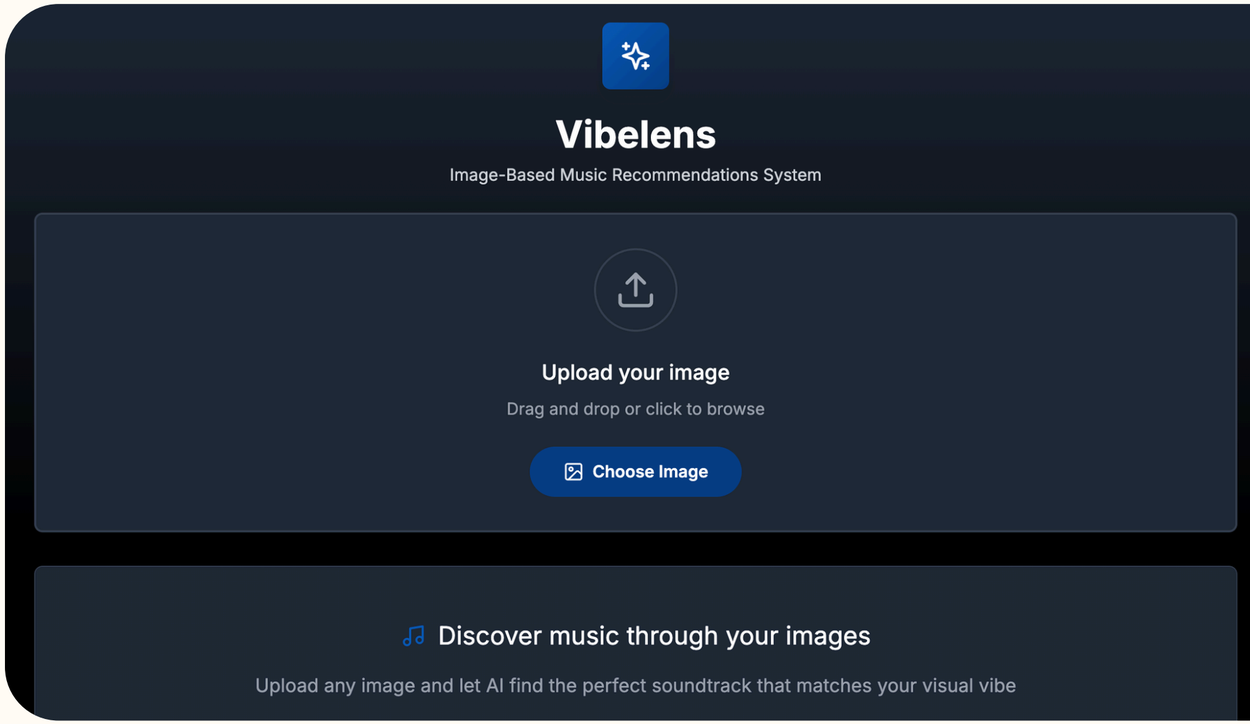
Achievements

- Good semantic relevance and <3s latency in most cases; some limitations due to compute and data noise.
- Engineered a workaround using general-purpose VLMs + custom similarity logic.

DISCUSSION

Project Limitations

- **Infrastructure Constraints:** Limited budget restricted access to high-performance GPU/cloud servers, resulting in slower inference and limited testing capacity.
- **Data Quality Issues:** Scraped lyrics often contained noise or inconsistent formatting. Some MP3 files were outdated or did not align properly with lyrics.
- **Model Generalization:** Used general-purpose vision-language models (e.g., ViT-GPT2) that were not specifically trained for music-related tasks, reducing alignment accuracy.
- **Limited Evaluation Scope:** Reliance on cosine similarity and qualitative feedback for evaluation, without large-scale user testing or A/B benchmarking.
- **Language and Cultural Bias:** Most dataset entries were in Vietnamese, limiting diversity in music genres, languages, and emotional expression.



CONCLUSION & FUTURE WORK

Recap of Achievements

- Built a **complete image-to-music recommendation system** using vision-language models, semantic vector search, and a modular full-stack architecture.
- **Successfully connected visual semantics with music content**, delivering emotionally resonant song suggestions.
- **Developed and deployed core components**: image captioning, data crawling, audio segmentation, vector embedding, and web interface.

Broader Implications

- Vibelens demonstrates a novel way to **enhance multimedia experiences through AI-driven content personalization**.
- **Has potential for integration into social media**, photo apps, or creative tools to enrich user-generated content.
- **Showcases how cross-modal AI** (vision + language + audio) can unlock deeper contextual understanding.

Future Development

- **Optimize latency and scalability** for real-world deployment (e.g., GPU inference, cloud scaling).
- **Expand the dataset** with global music diversity and higher-quality metadata.
- **Enable multi-language support** and mood-based filters for more personalized user experience.

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Acknowledgments

Our Progress

We would like to express our sincere gratitude to the individuals who supported and guided us throughout the development of Vibelens:

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- Prof. Kok-Seng Wong – Project Supervisor
- Prof. Pham Huy Hieu – Course Instructor (COMP3080)

Our Team:

- Nguyen Dai An – ML/NLP Specialist
- Nguyen Tien Nhan – Data Engineer
- Le Mai Thanh Son – Backend Developer
- Nguyen Xuan Truong – DevOps Engineer
- Nguyen Son Giang – Algorithm Specialist

Thank you for your guidance, dedication, and teamwork!

Thank You So Much!

Any question?