The Journal of Open Source Software

When Content Speaks Volumes: Podcastfy — An Open Source Python Package Bridging Multimodal Data and Conversational Audio with GenAI

Tharsis T. P. Souza [1,2]

1 Columbia University in the City of New York **2** Instituto Federal de Educacao, Ciencia e Tecnologia do Sul de Minas (IFSULDEMINAS)

DOI: 10.xxxxxx/draft

Software

- Review
- Repository
- Archive

Editor: Open Journals

Reviewers:

- @openjournals

Submitted: 01 January 1970
Published: unpublished

Abstract

Podcastfy is an open-source Python framework that programmatically transforms multisourced, multimodal content into multilingual, natural-sounding audio conversations using generative AI. By converting various types of digital content - including images, websites, YouTube videos, and PDFs - into conversational audio formats, Podcastfy enhances accessibility, engagement, and usability for a wide range of users. As an open-source project, Podcastfy benefits from continuous community-driven improvements, enhancing its adaptability to evolving user requirements and accessibility standards.

Statement of Need

The rapid expansion of digital content across various formats has intensified the need for tools capable of converting diverse information into accessible and digestible forms (Chen & Wu, 2023; Johnson & Smith, 2023; McCune & Brown, 2023). Existing solutions often fall short due to their proprietary nature, limited multimodal support, or inadequate accessibility features (Gupta & Lee, 2023; Marcus & Zhang, 2019; Peterson & Allen, 2023).

Podcastfy addresses this gap with an open-source solution that supports multimodal input processing and generates natural-sounding, summarized conversational content. Leveraging advances in large language models (LLMs) and text-to-speech (TTS) synthesis, Podcastfy aims to benefit a diverse group of users — including content creators, educators, researchers, and accessibility advocates — by providing a customizable solution that transforms digital content into multilingual textual and auditory formats, enhancing accessibility and engagement.

Features

- Generate conversational content from multiple sources and formats (images, websites, YouTube, and PDFs).
- Customize transcript and audio generation (e.g., style, language, structure, length).
- Create podcasts from pre-existing or edited transcripts.
- Leverage cloud-based and local LLMs for transcript generation (increased privacy and control).
- Integrate with advanced text-to-speech models (OpenAI, ElevenLabs, and Microsoft Edge).
- Provide multi-language support for global content creation and enhanced accessibility.
- Integrate seamlessly with CLI and Python packages for automated workflows.

See audio samples.

The Journal of Open Source Software

Implementation and Architecture

`Podcastfy` implements a modular architecture designed for flexibility and extensibility through five main components, as shown in Figure 1.

1. **Client Interface**
   - Provides both CLI (Command-Line Interface) and API interfaces.
   - Coordinates the workflow between processing layers.
   - Implements a unified interface for podcast generation through the `generate_podcast()` method.
2. **Configuration Management**
   - Offers extensive customization options through a dedicated module.
   - Manages system settings and user preferences, such as podcast name, language, style, and structure.
   - Controls the behavior of all processing layers.
3. **Content Extraction Layer**
   - Extracts content from various sources, including websites, PDFs, and YouTube videos.
   - The `ContentExtractor` class coordinates three specialized extractors:
     - `PDFExtractor`: Handles PDF document processing.
     - `WebsiteExtractor`: Manages website content extraction.
     - `YouTubeTranscriber`: Processes YouTube video content.
   - Serves as the entry point for all input types, providing standardized text output to the transcript generator.
4. **LLM-based Transcript Generation Layer**
   - Uses large language models to generate natural-sounding conversations from extracted content.
   - The `ContentGenerator` class manages conversation generation using different LLM backends:
     - Integrates with LangChain to implement prompt management and common LLM access through the `BaseChatModel` interface.
     - Supports both local (`LlamaFile`) and cloud-based models.
     - Uses `ChatGoogleGenerativeAI` for cloud-based LLM services.
   - Allows customization of conversation style, roles, and dialogue structure.
   - Outputs structured conversations in text format.
5. **Text-to-Speech (TTS) Layer**
   - Converts input transcripts into audio using various TTS models.
   - The `TextToSpeech` class implements a factory pattern:
     - The `TTSFactory` creates appropriate providers based on configuration.
     - Supports multiple backends (OpenAI, ElevenLabs, and Microsoft Edge) through the `TTSProvider` interface.
   - Produces the final podcast audio output.

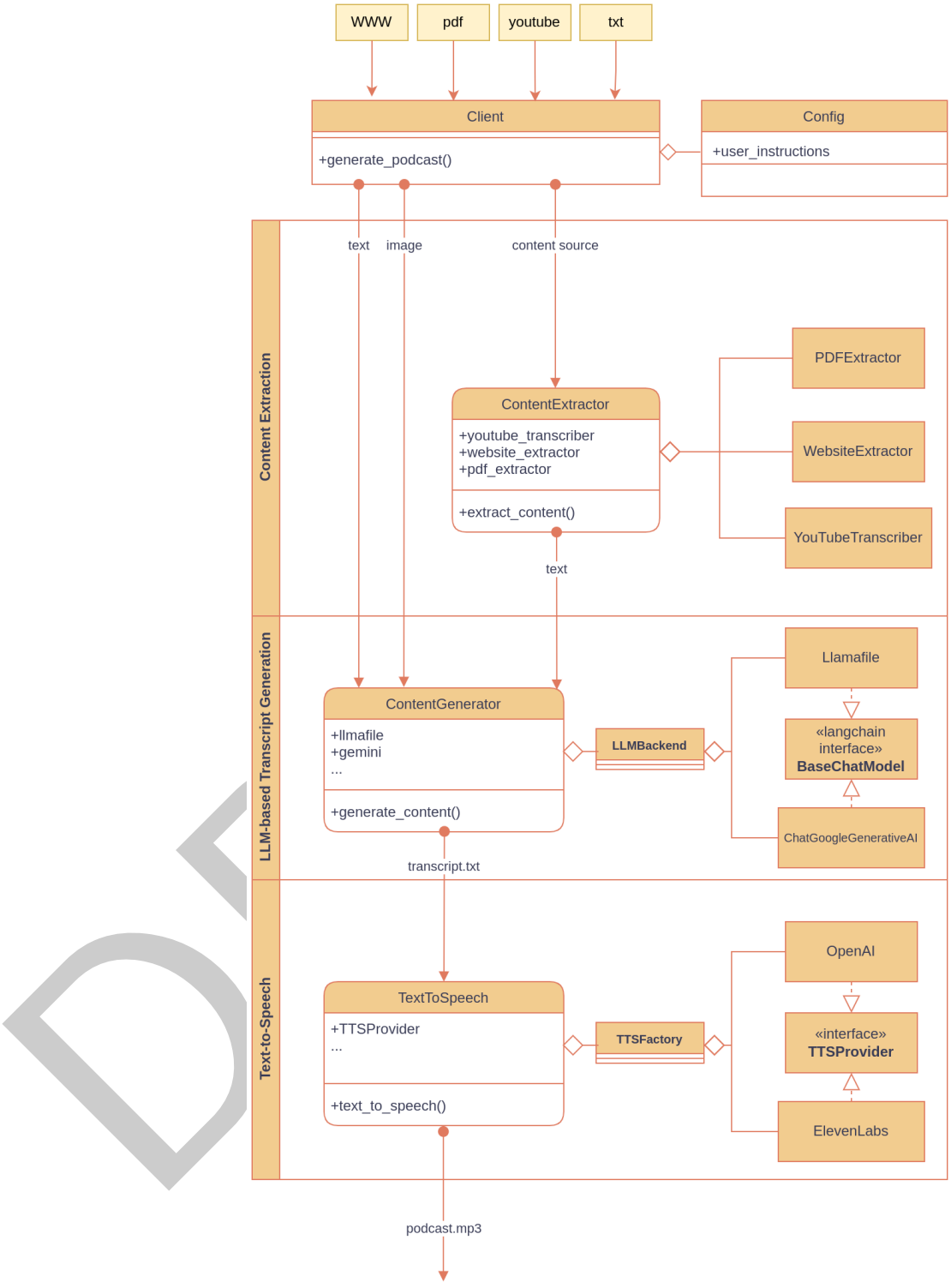

Figure 1: Podcastfy's simplified architecture and workflow diagram showing the main components and their interactions.

The modular architecture enables independent development and maintenance of each component. This pipeline design ensures a clean separation of concerns while maintaining seamless data transformation between stages. This modular approach also facilitates easy updates and

extensions to individual components without affecting the rest of the system.

The framework is offered as a Python package, with a command-line interface as well as a REST API, making it accessible to users with different technical backgrounds and requirements.

Quick Start

Prerequisites

- Python 3.11 or higher
- `$ pip install ffmpeg` (for audio processing)

Setup

1. Install from PyPI `$ pip install podcastfy`
2. Set up API keys

Python

```python
from podcastfy.client import generate_podcast

audio_file = generate_podcast(urls=["<url1>", "<url2>"])
```

CLI

```
python -m podcastfy.client --url <url1> --url <url2>
```

Customization Examples

Podcastfy offers various customization options that make it versatile for different types of content transformation. To accomplish that, we leverage LangChain's (LangChain, 2024) prompt management capabilities to dynamically construct prompts for the LLM, adjusting conversation characteristics such as style, roles, and dialogue structure. Below are some examples that demonstrate its capabilities.

Academic Debate

The following Python code demonstrates how to configure Podcastfy for an academic debate:

```python
from podcastfy import generate_podcast

debate_config = {
    "conversation_style": ["formal", "debate"],
    "roles_person1": "main presenter",
    "roles_person2": "opposing viewpoint",
    "dialogue_structure": ["Introduction", "Argument Presentation", "Counterarguments",
}

generate_podcast(
    urls=["PATH/TO/academic-article.pdf"],
    conversation_config=debate_config
)
```

In this example, the roles are set to "main presenter" and "opposing viewpoint" to simulate an academic debate between two speakers on a chosen topic. This approach is especially useful

for educational content that aims to present multiple perspectives on a topic. The output is structured with clear sections such as introduction, argument presentation, counterarguments, and conclusion, allowing listeners to follow complex ideas easily.

Technical Tutorial

In this example, the configuration is optimized for creating technical tutorial content.

```
tutorial_config = {
    "word_count": 2500,
    "conversation_style": ["instructional", "step-by-step"],
    "roles_person1": "expert developer",
    "roles_person2": "learning developer",
    "dialogue_structure": [
        "Concept Introduction",
        "Technical Background",
        "Implementation Steps",
        "Common Pitfalls",
        "Best Practices"
    ],
    "engagement_techniques": [
        "code examples",
        "real-world applications",
        "troubleshooting tips"
    ],
    "creativity": 0.4
}

generate_podcast(
    urls=["https://tech-blog.com/tutorial"],
    conversation_config=tutorial_config
)
```

The roles are set to "expert developer" and "learning developer" to create a natural teaching dynamic. The dialogue structure follows a logical progression from concept introduction through implementation and best practices. The engagement_techniques parameter ensures the content remains practical and applicable by incorporating code examples, real-world applications, and troubleshooting guidance. A moderate creativity setting (0.4) maintains technical accuracy while allowing for engaging explanations and examples.

Limitations

`Podcastfy` faces several key limitations in its current implementation. The accuracy and quality of generated content heavily depends on the underlying LLMs, with complex technical content potentially being misinterpreted. Additionally, while multilingual support is available, performance varies across languages, with less common languages having limited TTS voice options. The framework also relies on third-party APIs which introduces service availability risks, and local LLM options require significant computational resources.

These limitations highlight areas for future development and improvement of the framework. Users should carefully consider these constraints when implementing `Podcastfy` for their specific use cases and requirements.

Conclusion

`Podcastfy` contributes to multimodal content accessibility by enabling the programmatic transformation of digital content into conversational audio. The framework addresses accessibility needs through automated content summarization and natural-sounding speech synthesis. Its modular design and configurable options allow for flexible content processing and audio generation workflows that can be adapted for different use cases and requirements.

Acknowledgements

We acknowledge the open-source community and the developers of the various libraries and tools that make `Podcastfy` possible. Special thanks to the developers of LangChain, Llamafile and HuggingFace. We are particularly grateful to all our contributors who have helped improve this project.

References

Chen, R., & Wu, Y. (2023). Digital accessibility tools for multimodal content processing: A systematic review. *Digital Transformation Review*, *5*(3), 91–109.

Gupta, S., & Lee, A. (2023). Advances in adaptive user interfaces for enhanced accessibility. *Journal of Accessibility and User Experience*, *14*(3), 203–215.

Johnson, L., & Smith, K. (2023). Adaptive user interfaces for accessibility across digital content modalities. *Journal of Multimodal Accessibility*, *17*(2), 43–58. https://link.springer.com/article/10.1007/s12193-023-00427-4

LangChain. (2024). *LangChain: Building applications with LLMs through composability*. https://www.langchain.com/

Marcus, A., & Zhang, T. (2019). Design for multimodal human-computer interaction. In *Lecture notes in computer science* (Vol. 1157, pp. 160–176). https://link.springer.com/chapter/10.1007/978-3-319-52162-6_18

McCune, B., & Brown, L. (2023). Accessibility of digital information: Standards, frameworks, and tools related to information literacy and information technology. *Journal of Information Literacy and Accessibility*, *9*(4), 112–129.

Peterson, L., & Allen, J. (2023). Web accessibility and multimodal digital engagement. *Technology Accessibility Journal*, *12*(1), 23–34.