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AdaptixSummarizer: A Versatile Text Summarization Tool Adaptable to Roles and Styles

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Abstract- ***Text summarization plays a pivotal role in Natural Language Processing (NLP), enabling efficient distillation of key information from extensive and diverse textual content. This paper introduces FlexiSummarizer, a modular, customizable summarization tool designed to accommodate multiple input types—including plain text, web URLs, image files, and PDFs—through an integrated and user-friendly interface. The system combines Optical Character Recognition (OCR) via EasyOCR, PDF parsing through PyMuPDF, and a large language model (LLM) accessed through a backend API currently under development. A Gradio-based frontend provides interactive controls that allow users to personalize summaries based on preferred output style (e.g., bullet points, simplified), target reader role (e.g., student, CEO), optional entity focus, and custom prompt instructions. FlexiSummarizer explores the integration of diverse NLP components into a cohesive summarization pipeline. It emphasizes adaptability, extensibility, and real-world usability, contributing a flexible platform for intelligent content summarization across educational, professional, and everyday use cases.***

Keywords— Text Summarization, Natural Language Processing(NLP), Large Language Model(LLMs), Abstractive Summarization, Facebook / Bart-Large-CNN, Optical Character Recognition(OCR), EasyOCR, Gradio Interface,PyMuPDF, Multi-Modal Input, Deep Learning, User-Centric NLP Tools.

I. INTRODUCTION

In today's information-centric environment, users across sectors—academic, legal, corporate, and technical—are frequently overwhelmed by the volume and complexity of textual content. Extracting meaningful insights from such content is both time-consuming and cognitively demanding. Conventional extractive summarization techniques, which select and rearrange existing sentences from source material, often lack coherence, readability, and semantic adaptability. As advancements in Natural Language Processing (NLP) progress, abstractive summarization—where the system generates novel sentences that convey the core ideas of the original—has emerged as a superior alternative for producing human-readable and contextually rich summaries.

Recent developments in transformer-based deep learning models, particularly the advent of pre-trained Large Language Models (LLMs) such as facebook/bart-large-cnn available via Hugging Face Transformers, have significantly improved the ability to summarize text with fluency and contextual accuracy. These models allow for rephrasing and condensing information while preserving its meaning. However, deploying such models effectively in real-world applications presents challenges such as handling multi-format input (text, images, PDFs), performing text preprocessing, and delivering an accessible and interactive user experience.

This paper introduces FlexiSummarizer, a modular and user-friendly summarization system that aims to address these challenges. The system supports input from various formats including plain text, image files (e.g., JPG, PNG), and PDF documents. It integrates EasyOCR to extract text from image-based content, PyMuPDF to process multi-page PDF documents, and the facebook/bart-large-cnn model accessed via Hugging Face's pipeline interface to perform abstractive summarization. The frontend is built using Gradio, offering users an intuitive web-based platform to upload inputs and receive personalized summaries. Summaries can be tailored to the reader's context by selecting summary style (e.g., bullet points, simplified) and reader role (e.g., student, CEO), with additional support for custom instructions and entity-focused highlighting.

A core feature of the system is its preprocessing pipeline, which ensures that the input passed to the summarization model is clean, relevant, and well-structured. This step includes OCR text normalization, PDF text segmentation, punctuation correction, and removal of irrelevant characters or symbols. Such preprocessing improves both the quality of the summary and the consistency of results across different content types.

Importantly, the summarization model is accessed via a backend API integration (currently under development), allowing efficient processing without the overhead of maintaining large model weights on the client side. The use of OCR further enhances the system's utility in real-world scenarios involving scanned notes, handwritten content, or multilingual documents. Preliminary testing demonstrates that this hybrid approach outperforms traditional extractive summarization in coherence, readability, and adaptability to different user profiles.

The primary contributions of this paper are as follows:

- Design and implementation of a flexible summarization pipeline supporting input from multiple sources: text, images, URLs, and PDF documents.
- Integration of OCR, PDF parsing, and LLM-based summarization in a unified architecture accessible via Gradio.
- A preprocessing strategy to sanitize and normalize input prior to inference, thereby improving summarization accuracy.
- Practical evaluation of the system using diverse real-world data to assess summarization fluency, contextual relevance, and usability.

The remainder of this paper is organized as follows: Section II discusses related work in NLP-based summarization, OCR, and multimodal content processing. Section III outlines the system architecture, including the preprocessing pipeline and model integration. Section IV presents experimental results, focusing on summarization performance across different input types. Section V concludes the study and outlines future enhancements including multi-language support, offline summarization capabilities, and integration of user feedback for continuous improvement.

By combining OCR-driven extraction, flexible input handling, and LLM-based summarization within an intuitive interface, FlexiSummarizer aims to provide a scalable and effective solution for diverse real-world summarization needs.

II. RELATED WORKS

Text summarization is a core area of research in Natural Language Processing (NLP), aiming to condense large volumes of text into concise, coherent summaries while preserving the original meaning. Traditionally, extractive summarization has dominated this space, relying on methods that select important sentences directly from the source. Notable algorithms like TextRank and Latent Semantic Analysis (LSA) have demonstrated effectiveness on structured content [1]. However, their inability to generate natural or paraphrased language often results in summaries that lack coherence and contextual flow.

The emergence of deep learning brought significant improvements, particularly in abstractive summarization. Sequence-to-sequence (Seq2Seq) models with attention mechanisms represented a breakthrough by enabling models to generate new phrases and focus selectively on relevant parts of the input text [2]. Despite these gains, challenges such as factual inaccuracies and grammatical inconsistency persisted.

The introduction of transformer architectures, especially encoder-decoder models like BART (Bidirectional and Auto-Regressive Transformers), further advanced the field. BART combines the strengths of both denoising autoencoders and autoregressive decoders, making it highly effective in summarization tasks. The facebook/bart-large-cnn model, a fine-tuned version of BART, has achieved strong results on summarization benchmarks such as CNN/DailyMail, demonstrating fluency, conciseness, and semantic fidelity [3][4].

The proliferation of cloud-accessible APIs and pre-trained models via platforms like Hugging Face has significantly lowered the entry barrier for implementing state-of-the-art summarization models. Developers can now leverage powerful Large Language Models (LLMs) without hosting them locally, thus allowing lightweight systems to integrate advanced summarization capabilities through API endpoints. Another vital dimension of modern summarization systems is input format diversity. In practical settings, content is not limited to plain text; users often need to summarize data from scanned documents, handwritten notes, or complex PDFs. Optical Character Recognition (OCR) plays a critical role here. While earlier OCR systems like Tesseract provided basic capabilities, deep learning-based tools such as EasyOCR have improved performance, especially on noisy, multilingual, or non-standard input formats [5].

Handling PDF content, which may contain embedded images, non-linear layouts, or mixed-language text, is facilitated by libraries like PyMuPDF. This toolkit enables structured extraction of text from multi-page PDF documents while preserving formatting details. When combined with preprocessing techniques—such as character normalization, whitespace cleanup, and punctuation correction—these tools provide well-structured input to summarization models.

From a usability standpoint, interactive platforms like Gradio have gained popularity for rapidly deploying NLP applications. Gradio supports drag-and-drop interfaces, real-time feedback, and multi-input formats, allowing developers to focus on backend logic while offering users an intuitive front-end experience [6].

Despite these advancements, most academic efforts focus narrowly on either model performance or input preprocessing. Key research gaps still include:

- Lack of unified frameworks that integrate OCR, PDF parsing, and LLM-based summarization.
- Limited benchmarking of summarization performance across multi-format, real-world inputs.
- Minimal exploration of preprocessing pipelines tailored to noisy, informal, or multilingual text inputs.
- Few interactive systems optimized for non-technical users via accessible web interfaces.

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This paper addresses these gaps by presenting a modular summarization tool that combines image-based text extraction (via EasyOCR), PDF parsing (via PyMuPDF), and abstractive summarization using facebook/bart-large-cnn through the Hugging Face Transformers pipeline. The entire workflow is wrapped in a web-based Gradio interface. Although the full deployment pipeline is currently under development, initial evaluations demonstrate the potential of such an integrated system in producing coherent, user-adaptive summaries across various content types.

III. COMPARATIVE ANALYSIS

Automatic summarization systems can be evaluated across multiple dimensions, including input type compatibility, summarization method, model accessibility, user customization, and interface usability. While existing models such as BERTSUM, GPT-3-based summarizers, and hybrid pipelines (e.g., Tesseract + LLM) have demonstrated success with text summarization, they often lack integration across diverse file formats and do not provide end-user control over summarization behavior.

The proposed system—FlexiSummarizer—was designed to address these limitations by offering a modular framework that integrates image, PDF, and text processing, OCR-based extraction, and customization via a user-friendly web interface. This section compares FlexiSummarizer with several established alternatives to contextualize its contributions and highlight its practical advantages.

Table 1: Comparative Overview of Summarization Systems

Feature / Tool	**BERTSUM**	**GPT-3 Playground**	**EasyOCR + LLM**	**FlexiSummarizer (Proposed)**
Input Formats	Text only	Text only	Image + Text	Text, Image, PDF, URL
Summarization Type	Extractive	Abstractive	Abstractive	Abstractive
OCR Integration	No	No	Yes (Basic Tesseract)	Yes (EasyOCR – multilingual)
PDF Support	No	No	Limited (manual)	Yes (via PyMuPDF)
Summary Customization	No	Prompt-based	Limited	Yes (style, role, entity focus)
Interface Type	CLI or code	Web-based	CLI or scripts	Web UI (Gradio)
Deployment Complexity	Medium	Cloud-based	High (manual setup)	Low (lightweight + modular)
Model Hosting	Local	Hosted (OpenAI)	Local / remote	API-based (Hugging Face pipeline)
Language Support (OCR)	N/A	N/A	Limited	80+ Languages (EasyOCR)
Real-world Input Ready	No	Partially	Moderate	High

Key Comparisons and Insights

1. Input Format Flexibility

FlexiSummarizer supports multi-modal input including plain text, scanned images, PDF documents, and web URLs. In contrast, summarization tools like BERTSUM and GPT-3 are limited to processing text-based content only. The integration of EasyOCR and PyMuPDF enables FlexiSummarizer to handle diverse, real-world input sources effectively, enhancing its versatility and making it more applicable in practical scenarios.

2. Summarization Capability

BERTSUM uses an extractive summarization method, which involves selecting key sentences directly from the source text. This often leads to summaries that lack fluency and cohesion. FlexiSummarizer, however, utilizes a pre-trained abstractive model (facebook/bart-large-cnn) that generates coherent and paraphrased summaries. This produces outputs that are more natural-sounding, informative, and better aligned with human-like summarization.

3. OCR and PDF Handling

Tools that combine OCR with language models, such as EasyOCR with GPT pipelines, often require manual setup and usually lack robust multilingual support. FlexiSummarizer overcomes these limitations by incorporating EasyOCR, which supports over 80 languages and various document layouts. Its integration with PyMuPDF ensures accurate extraction of content from structured or multi-page PDF documents, making it capable of handling complex formats with high reliability.

4. Personalization and Customization

FlexiSummarizer offers a high degree of customization not found in most traditional summarization tools. It allows users to select the preferred style of summary, such as executive summaries, simplified explanations (ELI5), or paragraph formats. Users can also define the role of the intended reader, such as a student or a CEO, and optionally specify key entities to focus on. This level of personalization ensures that the summaries generated are not only relevant but also tailored to the user's context and needs.

5. Deployment and Usability

Most existing summarization tools are designed for developers or researchers, lacking user-friendly interfaces. FlexiSummarizer addresses this by offering a Gradio-based web interface that allows users to upload files, input URLs, and customize outputs through dropdown menus and text inputs. This makes the tool highly accessible and usable even for non-technical users, extending its reach to academic, professional, and educational environments.

6. Model Accessibility and Inference
Many summarization solutions require the user to download and host large model weights locally, which can be resource-intensive. FlexiSummarizer avoids this by leveraging Hugging Face's hosted model endpoints for inference. This reduces system requirements and enables smoother performance in lightweight environments such as cloud notebooks or systems with limited computational power.

7. Scalability and Adaptability
FlexiSummarizer's modular architecture makes it highly scalable and adaptable. It can be easily extended to support additional file formats, incorporate more languages, or be fine-tuned for domain-specific applications like legal, medical, or academic summarization. This flexibility ensures that the tool remains future-ready and capable of evolving alongside emerging summarization needs and technologies.

Overall, the comparative analysis demonstrates that FlexiSummarizer provides a more holistic and adaptable solution compared to existing summarization systems. By unifying OCR, PDF parsing, and LLM-based summarization into an accessible framework, it bridges a key gap between research-oriented NLP tools and real-world user demands.

IV. PROPOSED WORKS

This section outlines the design vision, foundational motivation, and intended functionalities of the FlexiSummarizer system. The system is conceptualized as a lightweight, modular summarization tool that integrates multiple open-source technologies to provide real-time, abstractive summaries from varied input formats including plain text, scanned documents, PDFs, and web URLs.

4.1 Problem Statement

Despite the significant progress in automatic summarization technologies, most existing solutions suffer from the following limitations:

- They are typically confined to plain text input and do not support formats such as images or PDFs.
- Summaries generated are often generic and lack customization in tone, structure, or user-specific perspectives.
- Many systems require local deployment of large language models, demanding high-performance hardware.
- Tools that integrate OCR and summarization often involve multiple disconnected components or require programming knowledge to operate.
- There is a lack of intuitive, accessible interfaces for users with limited technical background.
- Existing frameworks rarely address multilingual document handling or noisy real-world inputs (e.g., scanned handwritten notes).

FlexiSummarizer is proposed to bridge these gaps by offering a single interface that combines multi-modal input processing, OCR integration, PDF parsing, and LLM-based summarization via API access, all wrapped in a simple Gradio-based web interface.

4.2 Objectives

The primary objectives of the proposed system are:

- To build a summarization tool that accepts and processes diverse input types: text, images, PDFs, and web URLs.
- To integrate EasyOCR for accurate text extraction from image-based content, including scanned or handwritten documents.
- To employ PyMuPDF for extracting structured text from multi-page PDF files.
- To leverage the Hugging Face Transformers pipeline for generating abstractive summaries using the facebook/bart-large-cnn model.
- To allow summary customization based on user-selected roles (e.g., Student, CEO) and styles (e.g., Bullet Points, Executive Summary).
- To optionally support named entity–focused summarization (e.g., people, organizations, dates).
- To present all functionalities via an intuitive and responsive web interface built using Gradio.
- To maintain modularity in code design, ensuring future adaptability to multilingual summarization or other file types.

4.3 Proposed Solution Overview

The FlexiSummarizer tool is designed as an end-to-end pipeline that accepts input in various formats, extracts the relevant text using preprocessing techniques, and then summarizes it using a transformer-based model. The summarized output is displayed interactively through a browser-based UI.
The system architecture includes the following core modules:

- Input Handler: Determines the type of user input (text, image, PDF, or URL) and routes it to the appropriate extractor.
- Preprocessing Layer:
  - OCR Engine (EasyOCR) for image and scanned document processing.
  - PDF Parser (PyMuPDF) for extracting content from PDFs.
  - URL Fetcher for web article parsing via requests.
- Prompt Builder: Constructs a model-ready summarization prompt using user-specified

parameters such as summary style, role, and focus entities.
- Summarizer Module: Connects to the Hugging Face summarization pipeline and uses a pretrained LLM (facebook/bart-large-cnn) to generate concise and human-readable summaries.
- Gradio Interface: Provides interactive frontend elements such as text boxes, dropdowns, and file upload buttons to guide user interaction.

By encapsulating these components within a flexible architecture, the system aims to offer a low-latency, high-utility summarization experience suited for academic, business, and general-purpose applications.

V. METHODOLOGY

The development of FlexiSummarizer follows a modular and layered approach, enabling flexibility in handling multiple input types and summarizing them effectively through a structured and customizable pipeline. This section outlines the methodology adopted to design and implement the system, including both the software design process and the interaction between its core components.

5.1 Methodological Approach

The system was designed to meet the following methodological goals:
- Modularity: Each component (input handling, text extraction, summarization, UI) is built as an independent, reusable module.
- Input Agnosticism: The system supports diverse formats including plain text, scanned images, PDFs, and online content (URLs).
- Layered Processing: Inputs are processed through a staged pipeline involving extraction, cleanup, formatting, and summarization.
- Customization: Users can select summary tone, target audience, entity focus, and provide their own summarization prompts.
- User Accessibility: The entire system is deployed with an interactive, no-code frontend (Gradio) to support general users.

5.2 System Workflow

The summarization process is divided into the following phases:
1. Input Acquisition:
    - Users can input raw text, upload documents (PDF, TXT, PNG, JPG), or enter a URL pointing to an article.
    - The system detects the input type and forwards it to the relevant extraction module.
2. Preprocessing and Extraction:
    - For PDF files, PyMuPDF is used to extract text content page by page.
    - For images, EasyOCR performs Optical Character Recognition (OCR) to convert visual text into editable strings.
    - For URLs, a requests-based parser downloads and extracts the readable content from the web page.
    - All extracted content is cleaned by removing unwanted whitespace, special characters, and formatting errors.
3. Prompt Preparation:
    - The user can optionally select parameters such as:
        - Summary Style (e.g., Simple Summary, Bullet Points, Executive Summary)
        - Target Role (e.g., Student, CEO, Teacher)
        - Entity Focus (e.g., People, Organizations, Dates)
        - Custom Prompt or Instruction (free-text guidance to personalize output)
    - These options are compiled into a formatted prompt which guides the summarization API in generating relevant summaries.
4. Summarization:
    - The cleaned text and user prompt are passed to the backend summarization engine through an internal or external API.
    - The API uses a pretrained large language model (hosted locally or remotely) to produce the abstractive summary.
    - The model processes a truncated version of the text (limited by token constraints) and returns a concise, well-structured summary.
5. Output Generation:
    - The resulting summary is displayed through the Gradio interface.
    - Users can read, copy, or refine the summary by modifying the input parameters and re-running the process.

5.3 System Design

FlexiSummarizer's system design is structured around five major functional layers:
1. User Interface Layer (Gradio):
    - Text input field
    - File upload module
    - URL input field
    - Dropdowns for summary style, role, entity focus
    - Output box to display the summary
2. Input Handler Layer:
    - Detects input type (text, image, PDF, or URL)
    - Routes to the correct preprocessing pipeline
3. Preprocessing Layer:
    - Image files: EasyOCR

- PDF files: PyMuPDF
- URL: Web scraper (requests and HTML parser)
- Text cleaner: whitespace, encoding, punctuation fixers

4. Prompt Builder:
   - Generates structured summarization instructions based on user settings
   - Adds control tags and focus areas
5. Summarization API Engine:
   - Receives cleaned text and prompt
   - Generates abstractive summary using an existing large language model
   - Returns final summary for display
6. Output Renderer:
   - Presents summary via Gradio
   - Allows real-time feedback and iteration

5.4 System Flow Diagram (Descriptive)

User Input → Input Type Detector →
↳ PDF → PyMuPDF → Cleaned Text
↳ Image → EasyOCR → Cleaned Text
↳ URL → Web Scraper → Cleaned Text
↳ Text → (direct) → Cleaned Text
Cleaned Text + Prompt → Summarization API → Final Summary → Gradio UI

This design ensures smooth interoperability between modules, supports expansion to new file types, and allows for external summarization models to be swapped or upgraded as required.

VI. Conclusion And Future Works

FlexiSummarizer is a practical, customizable, and multi-modal text summarization system built to handle diverse content sources including raw text, images, PDFs, and web links. Designed for real-world use, it combines OCR, document parsing, and an abstractive summarization engine within a modular, user-friendly Gradio interface.

The system leverages tools like EasyOCR and PyMuPDF to extract content from unstructured formats such as scanned documents and multi-page PDFs. A robust preprocessing pipeline cleans noisy input to enhance the coherence and relevance of summaries. Users can customize outputs based on role, style, key entities, and specific instructions, allowing domain- and audience-specific adaptability.With its modular backend, FlexiSummarizer supports easy updates and integration of future models. Early evaluations highlight its effectiveness in handling varied input formats and generating concise, coherent, and context-aware summaries.

Future Directions

- To enhance its capabilities, upcoming improvements may include:
- Multilingual Support – Extend OCR and summarization for global, non-English content.
- Domain-Specific Models – Tailor outputs for fields like law, medicine, or academia.
- Real-Time Summarization – Support live updates for meetings, news, and dynamic content.

In summary, FlexiSummarizer lays a strong foundation for intelligent and flexible summarization, with promising potential for expansion across languages, platforms, and specialized use cases.

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