



BEYOND THE PDF: MEASURING THE IMPACT OF CONVERSATIONAL AND VISUAL AI FEATURES ON READER ENGAGEMENT IN DIGITAL LIBRARIES

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ABSTRACT

Physical cultural heritage preservation faces a key paradox. Delicate vintage books need limited handling for protection. Yet, restricting access reduces public reading and societal value. Standard digitization relies on flat scanning and basic Optical Character Recognition (OCR). This creates static repositories. These repositories fail to attract modern audiences. This paper presents an Artificial Intelligence (AI) framework. AI acts as an active engine to boost reader engagement. The system uses Computer Vision (CV) and Natural Language Processing (NLP). At the ingestion stage, Convolutional Neural Networks (CNNs) and Generative Adversarial Networks (GANs) clean digital images. They fix paper stains, ink bleed, and page curvature automatically. Transformer-based Handwritten Text Recognition (HTR) models process old typography and historical scripts. They ensure high accuracy for complex text layouts. Beyond text extraction, semantic AI layers create active engagement interfaces. Large Language Models (LLMs) and Retrieval-Augmented Generation (RAG) provide contextual support. They explain archaic terms, offer historical notes, and translate text inline. Dense vector search replaces rigid keyword matching. Readers can discover books using themes, moods, or historical events. Interactive features like AI book companions, neural audio synthesis, and scene visualization convert passive reading into a multi-sensory experience. Automated metadata enrichment creates personalized reading pathways. This bridges the gap between academic archives and public readers. Ultimately, AI transforms static digital files into living, engaging learning hubs.

KEYWORDS : Artificial Intelligence Digitization, Handwritten Text Recognition (HTR), Cultural Heritage Preservation, Interactive Reader Engagement, Retrieval-Augmented Generation (RAG), Semantic Text Processing

INTRODUCTION

Libraries and archives hold millions of rare historical books. However, physical wear limits public access to these texts (1). Old books often sit in closed storage rooms. Standard digital scanning creates digital images and flat PDF files. These files are hard to search and lack context. Modern readers often find them difficult to read.

AI technologies offer new solutions for libraries (2). Deep learning can fix damaged scans. Large language models can explain hard passages. AI transforms simple scans into active reading experiences. This paper explores an end-to-end AI framework for book digitization.

[Physical Book] → [AI Image Cleaning] → [HTR / Text Parsing] → [Semantic AI Layer] → [Interactive Reader Experience]

Deep Learning Pipelines for Page Digitization

Digitization starts with accurate page capture and text processing. Physical pages often have stains, shadows, or curved lines.

Image Restoration:-

Convolutional Neural Networks (CNNs) remove background noise from scans. Generative Adversarial Networks (GANs) fix page curvature near book spines. They remove bleed-through ink without losing historical text details.

Text Extraction:-

Traditional OCR fails on non-standard fonts and handwriting. Transformer-based Handwritten Text Recognition (HTR) models process entire lines of text (3). They read complex scripts and historical spellings with high accuracy.

Adding Context to Historical Texts:-

Readable text is just the first step. Old texts use forgotten idioms and archaic words. These barriers reduce reader interest.

Semantic AI layers solve this issue by adding real-time reading assistance:

A) Contextual Overlays:-

Retrieval Augmented Generation (RAG) links text passages to factual historical databases. Readers can click obscure words to see clear, inline definitions.

B) Modernized Translations:-

Natural Language Processing (NLP) models can translate older language forms into modern phrasing. Readers can toggle between historical and modern text views.

C) Semantic Discovery:-

Vector search allows users to find books by concepts rather than exact titles. Readers can search for specific story themes or historical settings easily.

Interactive Engagement Features:-

Digital texts must offer interactive features to capture user attention. AI tools convert static text into multimedia experiences.

Component	Underlying Technology	Impact on Reader Engagement
Conversational Companions	LLMs trained on specific book texts	Readers can ask questions directly to an AI representing the book or author.
Generative Audiobooks	Neural Text-to-Speech (TTS)	Synthesizes expressive voice narration for audio learning
Scene Visualizations	Diffusion Image Models	Generates contextual artwork from historical scene descriptions

Ethics and Quality Control:-

AI models can make errors or generate incorrect facts. Digitization projects need human oversight. Archivists must verify automated transcriptions and notes before publication (2,3). Clear labels should distinguish original texts from AI-generated explanations.

CONCLUSION:-

AI turns static digital scans into interactive reading tools. Deep learning improves image quality and text extraction. Language models explain complex context. Interactive media tools attract new readers to classic works. Through these tools, historical collections become vibrant, accessible sources for future generations

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