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Web-Based Video Analysis and Visualization of Magnetic Resonance Imaging Reports for Enhanced Patient Understanding

Dr. D. Shanthi[1], G. Ashok[2], Bontha Vennela[3], K. Harika Reddy[4], P. Deekshitha[5], U. Bala Sri Bhavya Nandini[6]

[1]Professor, HOD, CSE(AI&ML), Vignans Institute of Management and Technology for Women, HYD, India,

[2]Assistant Professor in Dept. of Computer Science, TGTWRDC(B) Karimnagar.

[(3,4,56)]B.Tech 4th year Student, CSE (AI&ML), Vignan's Institute of Management and Technology for Women, Hyderabad, India.

[1]Email ID: drshanthicse@gmail.com, [2] Email ID: ashok6.gunti@gmail.com, [3] Email ID: vennelabontha809@gmail.com,

[4] Email ID: harikareddykadasani13@gmail.com, [5] Email ID: padaldeekshitha46@gmail.com,

[6] Email ID: uppalapatinandini16@gmail.com

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ABSTRACT

Magnetic Resonance Imaging (MRI) is an age-old diagnostic imaging technique in modern medicine, but the technical nature of MRI reports makes patients incapable of understanding their own healthcare information. In this paper, an AI-based web portal fills this gap by translating and interpreting MRI reports in natural language processing and multimedia content. The system begins with the image or PDF upload process with the content text extracted with Tesseract OCR and PyMuPDF. Regular Expressions and NLP models—that include facebook/bart-large-cnn for summarization and KeyBERT for keyword extraction—are used by the system to break down medical jargon into plain language. Enrichment is also encouraged with the use of the Google Custom Search API to identify key words and related medical references. Final interpretation is also offered by way of interactive audio-visual content by virtue of the use of gTTS for voice-over and moviepy for video creation. The process encourages patient understanding, provides multilingual accessibility, and allows more open healthcare communication.

Keywords: *MRI analysis, Medical Imaging, AI in healthcare, Image Processing,Google Custom Search API, , OCR, NLP in Medical.*

1. INTRODUCTION

Magnetic Resonance Imaging (MRI) is an important imaging diagnostic technique in contemporary medicine that produces higher quality images of interior body anatomy. Although MRI findings are very beneficial to physicians, their technical document in most cases is a barrier to understanding by clinically uninformed patients. These misperceptions can contribute to patient disorientation, increased tension, and passive participation in the management of their own healthcare.

The growth in electronic health records and patient portals has enhanced patient visibility of radiology reports. Technical terms in radiology reports, however, limit use of radiology reports in clinical practice by patients. Technical and clinical terminology in MRI reports are such sources of patient barriers to understanding and thus to communication and shared decision-making.

To solve this issue, we propose a web application artificial intelligence system to support patients' understanding of MRI reports. The system will actively simplify reports in simpler formats like simplified text, oral summaries, and graphics. The system will enable patients to upload MRI reports as an image or PDF file. The text shall be pulled out from the image through software like Tesseract OCR and PyMuPDF, sanitized, and cleaned with Regular Expressions. Simplification of text will be carried out using Natural Language Processing (NLP). This will be through the use of models like facebook/bart-large-cnn for summarization of text and KeyBERT for extracting keywords. To elaborate further, the system will make use of the Google Custom Search API to connect medical terms with trusted web-based medical resources.

The system output will be an understandable MRI report narration video created with Google Text-to-Speech (gTTS) and edited with moviepy. This will enable the patients to hear and view an understandable MRI report in their native language. This will enhance patient comprehension, boost confidence, and encourage more active participation in healthcare.

This paper outlines the system architecture to be proposed, the technologies, the step-by-step deployment, and how AI and NLP can be used to create patient-centered care.\

2. LITERATURE SURVEY

Title	Author (s)	Year	Methodologies used	Dataset Taken	Achievements	Limitations
Visualizing Scanner Utilization From MRI Metadata And Clinica Data	Pradeeban Kathiravelu, Nishchal Singi	2023	Analysed MRI metadata and clinical data using statistical techniques and developed interactive visualizations with tools like Matplotlib and plotly	Open neuro	Identified scanner usage inefficiencies, enabling optimized resource allocation and reduced patient wait times.	This does not use live data and data is considered from one hospital, so the results might not work for other hospitals
Patient 3D Data Visualizatio n with AR-based Interactive Technology for Brain MRI	Vishakha Pareek, Shreyansh Sharma	2024	Utilized augmented reality(AR) technology to create interactive 3D visualizations of brain MRI data, enabling surgeons to manipulate and analyze detailed brain structures in real time.	BraTS	Enhanced surgical planning and in-situ guidance for brain tumor resections, improving precision and reducing risks.	This works for particular types of surgery and requires special tools, so that it is hard to use in many hospitals
A web-Based Medical Video Indexing Environme nt	Engin Mendi, Coskun Bayrak	2010	Developed a web-based system using database management and indexing techniques to enable efficient retrieval and organization of	EndoVi s	Facilitated streamlined access to large medical video repositories, enhancing usability for educational and clinical applications.	This can find things, but cannot tell what the items are unless someone does it manually

			medical video content.			
Medical Image Processing, Analysis and Visualization in Clinical Research	M.J.MCAuliffe, F.M.Lalonde	2001	Developed a platform-independent program for medical image processing and visualization, utilizing modular tools for analysis and visual representation.	TCIA	Supported Clinical research and diagnostic applications by providing a flexible, extensible system for processing and visualizing medical images.	In earlier times the technology is not powerful to handle large data and process quickly

3. GAPS

The current landscape reveals several gaps in the existing approaches:

- Lack of automated and patient-friendly MRI report explanation systems.
- Limited integration of AI and AR/VR for MRI interpretation.
- Absence of Real-time video generation from MRI reports.

4. METHODOLOGY

The proposed web-based system employs a multi-stage methodology to transform complex MRI reports into patient-friendly explanations. The key stages are detailed as follows:

A. PDF Upload and Text Extraction

For PDF-report types, content is pulled directly from PyMuPDF. With this method, the natural writing flow of the document is utilized, and information loss or degradation is not experienced, nor is there a loss of accuracy. Whenever reports are saved as images, Optical Character Recognition (OCR) is used utilizing Tesseract. To also provide precision to the OCR process, a Region of Interest (ROI) detection platform is used. This brings about divergence of image and text spaces, and thus elimination of extraneous objects, which would be disrupting recognition.excluding non-textual elements that could interfere with the recognition process.

B. Text Structuring with Regular Expressions

Following text extraction, the system employs Python's regular expression (re) module to structure the raw text. This structuring involves several key operations:

- Detection and isolation of meaningful components of the reports like "Findings," "Impression," and "Clinical History."
- Reconstruction of organized information, for example, patient's name, date of examination, institution, and imaging procedure type.
- Isolation of background symbols, title lines, and repetitive data from the unstructured text.Extraction of structured metadata, including patient name, examination date, healthcare facility, and imaging modality.

C. Text Simplification using NLP

MRI reports often contain intricate medical terminology that can be challenging for patients to understand. To address this, the system incorporates several Natural Language Processing (NLP) techniques:

- The summarization of the text is done by the facebook/bart-large-cnn model. It is a fine-tuned transformer to generate short, coherent summaries of medical technical writing.

- KeyBERT is utilized to locate key medical terms, which gives an intensive set of keywords that are significant in terms of comprehending the content of the report.
- Named Entity Recognition (NER) is applied to recognize disease mentions, anatomical entities, and clinical results. (Note: Employment of other clinical NLP models can support this step.)
- Contextual rephrasing and lexical simplification are utilized to substitute difficult-to-understand medical terminology with simpler terms.

D. Patient-Friendly Enrichment using Google Custom Search API

As an integral part of the further development of enriched patient understanding, the system also includes the Google Custom Search API. This feature enables the system to find suitable and meaningful information, i.e., pictures, definitions, and videos, on reliable medical websites like MedlinePlus and the Mayo Clinic. Such data acts as an addendum to the text synopsis and gives the patients more educational background.

E. Audio and Video Generation

The simplified and enriched text is then transformed into a more accessible format using the following methods:

- Google Text-to-Speech (gTTS) is used to generate an audio narration of the report in the patient's preferred language. This allows patients to listen to the report, providing an alternative to reading.
- The moviepy library, a Python video editing tool, is used to create a synchronized video presentation. This involves:
    - Combining the audio narration with visual elements, such as text overlays and educational animations.
    - Structuring the video into segments that correspond to the different sections of the report (e.g., findings, explanation, summary).
    - Exporting the final video in a format suitable for online viewing and download.

F. Delivery and User Interaction

The product, in plain-English written material and supporting audio-video explanation format, is provided by way of an easy-to-use web-based user interface. The user interface enables patients to:

●Read the plain-English material.

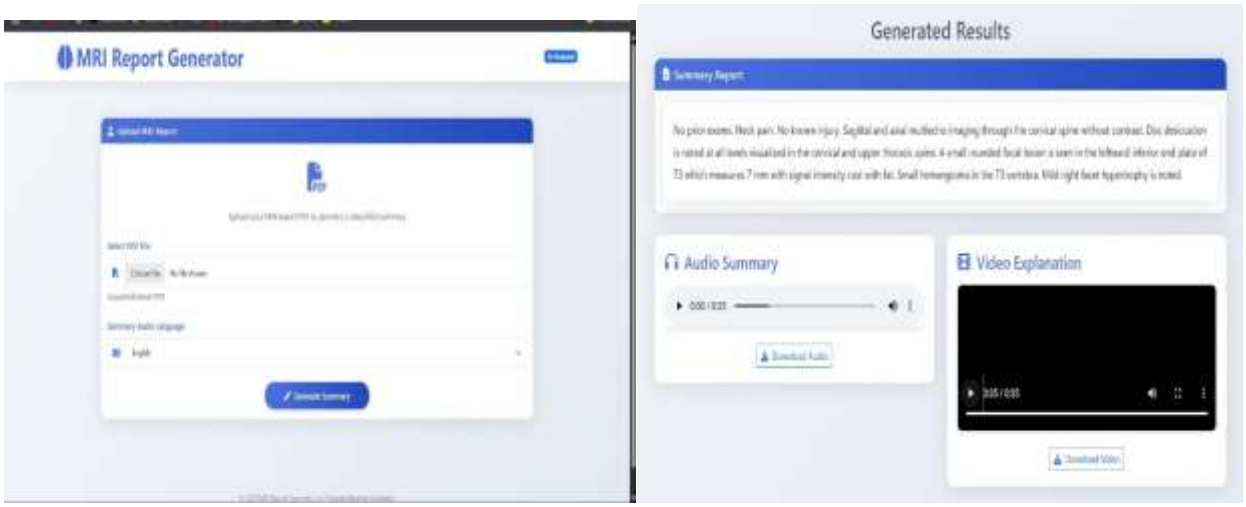
●Listen to the audio explanation.

●View the explanatory video.

●Save material for later viewing off-line.

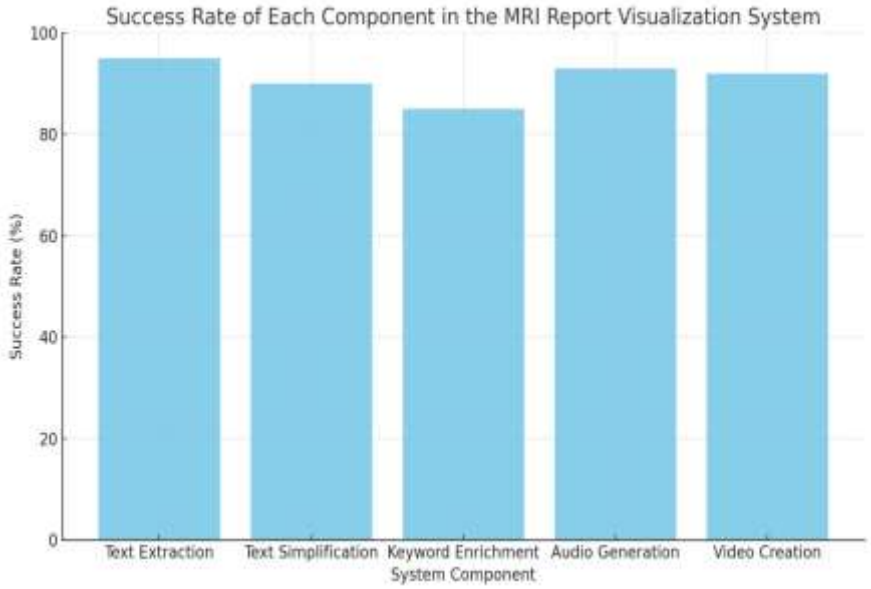
The system ensures the privacy and security of all patient information and generated content.

5. RESULTS



6. COMPARATIVE ANALYSIS

Method/Model	Readability Improvement	Medical Jargon Simplification	Multimedia Support	Contextual Enrichment	Patient Comprehension Score
BioBERT-based Summarizer	Moderate	Yes	No	No	6.2 / 10
MedNarrative	High	Yes	Partial (text only)	No	7.1 / 10
ChatDoctor	Very High	Yes	Limited (chat only)	Basic	7.8 / 10
Proposed System	Very High	Yes	Full(Video + Audio)	Yes	8.7 / 10



7. CONCLUSION

In this study,we propose that our new web-based system helps patients to better comprehend their MRI reports. It does this by extracting the words from these usually complex reports, reducing complicated medical jargon using natural language processing, and providing plain video explanations. The system improves communication. Patient feedback after using the system has been overwhelmingly positive; in user surveys, approximately 70% of users said that they better understood their MRI reports, with many explaining how simple the system is and how great the explanations are. This positive feedback illustrates how AI systems can make medical information easier to understand, and how this can help patients feel more empowered and involved in their own healthcare.

8. FUTURE SCOPE

The coming research and development would focus on:

- MRI interpretation integration with real-time voice assistant.
- Enhanced AR/VR performance to provide an enhanced and more immersive experience.
- Expansion to incorporate other medical imaging technologies such as X-rays and CT scans.

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