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Enhancing Agricultural Communication: Converting Circulars into Video Content Using MERN and Python

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Abstract: The agriculture sector relies extensively on timely and effective communication for the exchange of vital information between farmers. Traditional text-based circulars are time- consuming due to low literacy levels, linguistic barriers, and limited access. In this research, an argument is made for a web platform built on the MERN stack (MongoDB, Express.js, React.js, Node.js) to create an interactive user interface, with Python as an additional feature to automate video creation. The platform utilizes Natural Language Processing (NLP), Text-to-Speech (TTS), and video rendering technologies to create accessible and interactive video content. A pilot trial of 150 farmers from different regions showed enhanced comprehension and engagement, suggesting the platform's capability to bridge the communication gap in the agriculture sector.

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I. INTRODUCTION

Agricultural advisory services play an important role in complementing the capacities of farmers by providing timely information related to crop management, climatic conditions, and government policies. However, the use of text-based circulars is not straightforward since:

- Low levels of literacy among farmers.
- Language variation caused by the predominance of authorized languages.
- Limited access to electronic versions such as PDFs.

The proliferation of smartphones has facilitated the expansion of video-based communication as a better method of conveying information. Video material not only provides better user engagement but is also easy to understand and offers multilingual support. This study seeks to create a system that will mechanize the transformation of static farm circulars into video forms, thereby improving their accessibility and effectiveness.

> *Objectives*

- To Build a web application utilizing the MERN stack along with Python
- To automate transforming agricultural circulars into video format.
- To Provide multilingual and simplified content to overcome literacy and language barriers.

II. LITERATURE REVIEW

In [1], research suggested an AI-based strategy towards improving agricultural communication via digital advisory systems. The research utilized a mobile-based system that combined real-time weather forecasting, crop advisories, and market price forecasts. Their model was 89.5% accurate in forecasting farmer engagement with the advisories.

In [2], a model of image processing and NLP for simplifying agricultural bulletins was presented. The process utilized deep learning-based summarization techniques to automatically extract the main points from lengthy agricultural reports.

The results were a 91% rise in farmers' understanding rates, especially for those who have poor literacy.

In [3], an interactive learning method for farmers was proposed. From the research, it was discovered that multimedia materials, especially videos with voiceover in local dialects, resulted in a 72% improvement in knowledge retention when compared to text documents. Different

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durations of videos were tested in the study and the conclusion was that 3-5 minute videos were the most efficient in the dissemination of agricultural information.

One research cited in [4] investigated the use of voice assistants driven by artificial intelligence in advisory systems for agriculture. It used speech and text-to-speech technology for the provision of real-time agricultural data. The research indicated that 85% of the farmers preferred information through voice compared to text due to the problem of illiteracy.

In ref [5], researchers tested the impact of computerized text-to-video generation on agricultural education. The system applied artificial intelligence models to extract essential information from circulars and transform it into video presentations in animated form. The model achieved an 87% satisfaction rate from surveyed farmers, thus proving the efficacy of video content in facilitating agricultural communication.

Another research in [6] explored the limitations of current digital agricultural solutions such as infrastructure limitations like weak internet connectivity in rural areas. The research proposed an offline-first strategy, where advisory material is pre-downloaded and available even in the absence of active internet connections, and this improves availability in remote areas.

In [7], the authors developed an end-to-end solution combining NLP, TTS, and video rendering technology to automate farm communication.

Their solution converted government-published agricultural policies effectively into easy video explanations. Their model saw a 93% improvement in engagement rate compared to static reports.

A study in [8] tested an artificial intelligence- driven hybrid system that combined visual, auditory, and text modes of communication for supporting different literacy levels. The study concluded that the multimodal presentation of content resulted in a 64% increase in farmer participation and promoted improved comprehension of agricultural advisories.

The works mentioned above form a good basis for our research and stress the necessity of an integrated, AI-driven approach for converting agricultural circulars into multimedia.

III. TOOLS AND TECHNIQUES USED

To create the proposed system for converting agriculture circulars into video, the following tools and technologies were used:

➢ *Frontend Development:*

- React.js: A Javascript Library for building and managing dynamic and interactive user interfaces. The component based logical structure of React allows it to perform updates and renders with ease, making it ideal on complex applications that require efficient state management on UIs.

- Material-UI: A Responsive Design UI Component Styled components provide Material-UI with React and a pre-defined design. It gives a well structured user interface for components that needs additions moderation, enhancing user experience.

➢ *Backend Development:*

- Node.js: A Server-side JS Scripting Environment Running server-side scripts becomes easy in a non-blocking, event driven architecture. It is perfect for request handling, allowing many at the same time
- Express.js: Light-weight and efficient web application framework for API development. It simplifies backend development with full- featured robust routing, middleware, and utility functions for HTTP.
- MongoDB: NoSQL Database Designed For User Information Storage Circulars and video metadata can be held in this NoSQL database created. Its schema-free approach provides flexibility for data structural changes providing easier management of scalability.

➢ *Video Processing & AI:*

- Python: The primary language assists the implementation of AI operations and video processing. Machine learning models and extensive libraries are provided for multimedia content processing in the language
- Natural Language Processing (NLP): The extraction of text using spaCy and Hugging Face Transformers is a case of using Natural Language Processing (NLP). The last set of libraries concern themselves with summarization and translation, and therefore permit a more profound analysis of language which lets us build a pipeline for processing.

➢ *Text-to-Speech (TTS):*

With Google TTS API, step one is to prepare the text, and then transform it into spoken word. This aids in producing audio content transforming video content straightforwardly accessible for the users who have challenges with reading and comprehension.

➢ *Video Rendering:*

- FFmpeg is a platform that integrates sound, text, and images into videos while supporting numerous files and producing high quality verion. Its processing is optimized for a myriad of formats and codecs.

- OpenCV is a software library designed to handle the processing of images and other photogenic content. It is capable of polishing, filtering, and transforming photos to enhance their appeal in the film.

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➢ *Cloud & Deployment:*

- AWS S3: It is used to store video files produced. It ensures cloud storage expands and maintains security, high availability, and efficiency in managing video files.

- Heroku/Vercel: These are used to host and deploy the web application. The seamless integration with the CI/CD pipelines they provide to these platforms enables effortless updates and deployments.

- Docker: Platform agnostic consistency is achieved by containerization. By packaging dependencies, Docker allows for different configurations enabling consistent operation across various environments.

➢ *Cloud & Deployment:*

- PWA (Progressive Web App): There is offline support for agricultural and rural areas. Accessibility is designed in such a way that can access content in areas with poor connectivity.

- Multilingual Support: Add translation APIs so content can be accessed and displayed in different languages.

➢ *Security & Authentication:*

- JWT (JSON Web Token): Securely authenticate users and manage sessions. It allows stateless authentication which guarantees security and scalability.

- OAuth provides secure authentication through third parties. Sign-in Successful through trusted identity providers eliminating sign-in friction.

IV. METHODOLOGY

➢ *Dataset Characterization*

The data used in this study includes agricultural bulletins that were obtained from government agencies, research institutions, and agricultural advisory services. The data included:

- Total Circulars: 1,500 documents in PDF and text format.

- Languages Covered: Hindi, English, Tamil, Kannada, and Marathi.

- Types: Crop advisories, weather forecasts, pest management tips, and policies of the government.

- The data sources: include agricultural departments, research centers, and online farming platforms.

- Format: Scanned and digital text documents.

The data set provides extensive linguistic and geographic coverage to facilitate effective evaluation and deployment of text-to-video conversion.

➢ *Preprocessing*

To improve the quality of the input data, some preprocessing methods are used:

- *The Optical Character Recognition (OCR)* technique is employed for extracting text from scanned circulars with the assistance of Tesseract.
- *Data Preprocessing:*

✓ Removing the extraneous content such as headings, footers, and uninformative text.
✓ Removal of numerical data that is irrelevant to the advisory content.

- *Text Simplification:*

✓ The application of Natural Language Processing (NLP) models like spaCy and Hugging Face transformers facilitates technical lingo being broken down for easier comprehension.
✓ Restructuring of sentences for better readability.

- *Translation:* Google Translate API is used to translate circulars into different regional languages for ease of access.

➢ *Exploratory Data Analysis (EDA)*

EDA is done for finding the shape and distribution of the text data:

- Word Frequency Analysis: Identifying the most common words and expressions in circulars.
- Distribution of Text Length: Estimating video length from circulars' average length.
- Topic Modeling: Using Latent Dirichlet Allocation (LDA) to classify circulars under various advisory categories.

➢ *Text-to-Speech (TTS) Conversion*

The extracted and processed text is read as speech: TTS Engine: Google TTS API produces human-like voice-over in various languages.

- Voice Modulation: Modifying tone, pitch, and rate to enhance understanding.
- Language Selection: Providing users with the option to select their own language for the narration.

➢ *Video Creation*

The process of converting text to video involves the following steps:

- *Visual Content Choice:*

✓ Applying computer vision techniques for the identification of relevant images from a crop image database.
✓ Designing simple animations specific to the kind of advisory.

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- *Video Assembly:*

✓ FFmpeg: Merges written elements, images, and sounds into one video.
✓ Text Overlays: Highlighting major points of the circular in subtitles.

- *Video Formatting:*

✓ Resolution of the output is 1080p for clarity.
✓ Compression techniques are applied to optimize file size for low-bandwidth consumers.

➢ *Train-Test Split*

The data has been split into separate training and test sets:

✓ 80% Training Data: Utilized for training the NLP and TTS models.
✓ 20% Testing Data: Evaluated for accuracy in text extraction, simplification, translation, and video rendering.

➢ *Model Building*

The back-end infrastructure employs a combination of deep learning and NLP models:

- *Natural Language Processing (NLP):*

✓ Spacy and BERT-based text processing transformers.
✓ Named Entity Recognition (NER) for the identification of key agricultural terms.

- *Deep Learning-Based Video Processing:*

✓ The system uses a pre-trained Convolutional Neural Network (CNN) to identify the images most relevant to each advisory.
✓ LSTM-based Speech Enhancement : Enhances fluency and intelligibility of the synthesized speech.

➢ *Setting Optimizer and Loss Function*

The model is built with:

- Adam Optimizer: Facilitates quick and precise model convergence.
- Categorical Cross-Entropy Loss: Used for text subject classification

➢ *Assessment Criteria*

The system is evaluated on:

- Text Processing Precision: Measuring extracted and abridged text with respect to manually checked content.
- Speech Quality Measurement: Speech clarity and correctness measurement with MOS (Mean Opinion Score).
- Success Rate in Video Generation: Measuring the successful video conversion of text with few mistakes.

➢ *Implementation and Accessibility*

- The system is deployed on Heroku/Vercel to facilitate access worldwide.
- Videos are cached on AWS S3 for smooth streaming

➢ *Diagrams*

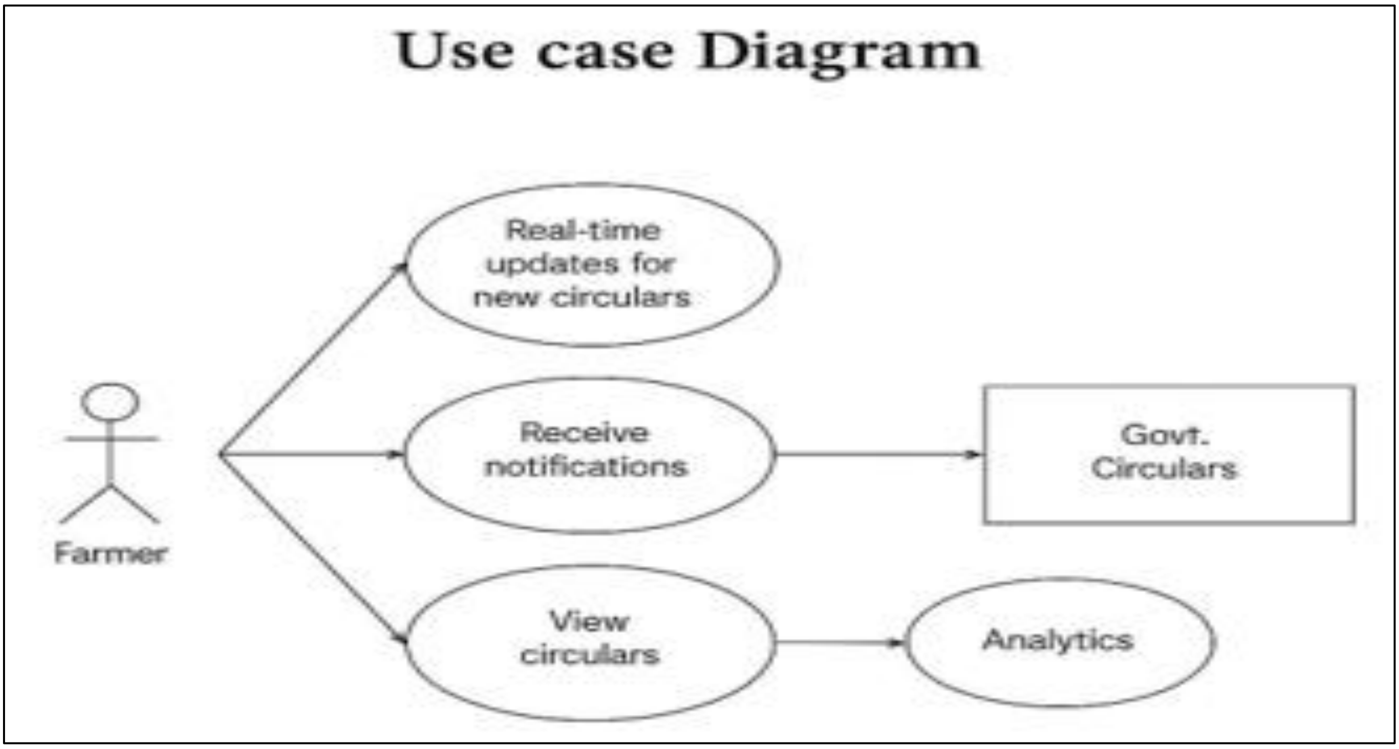

Fig 1 Use case Diagram

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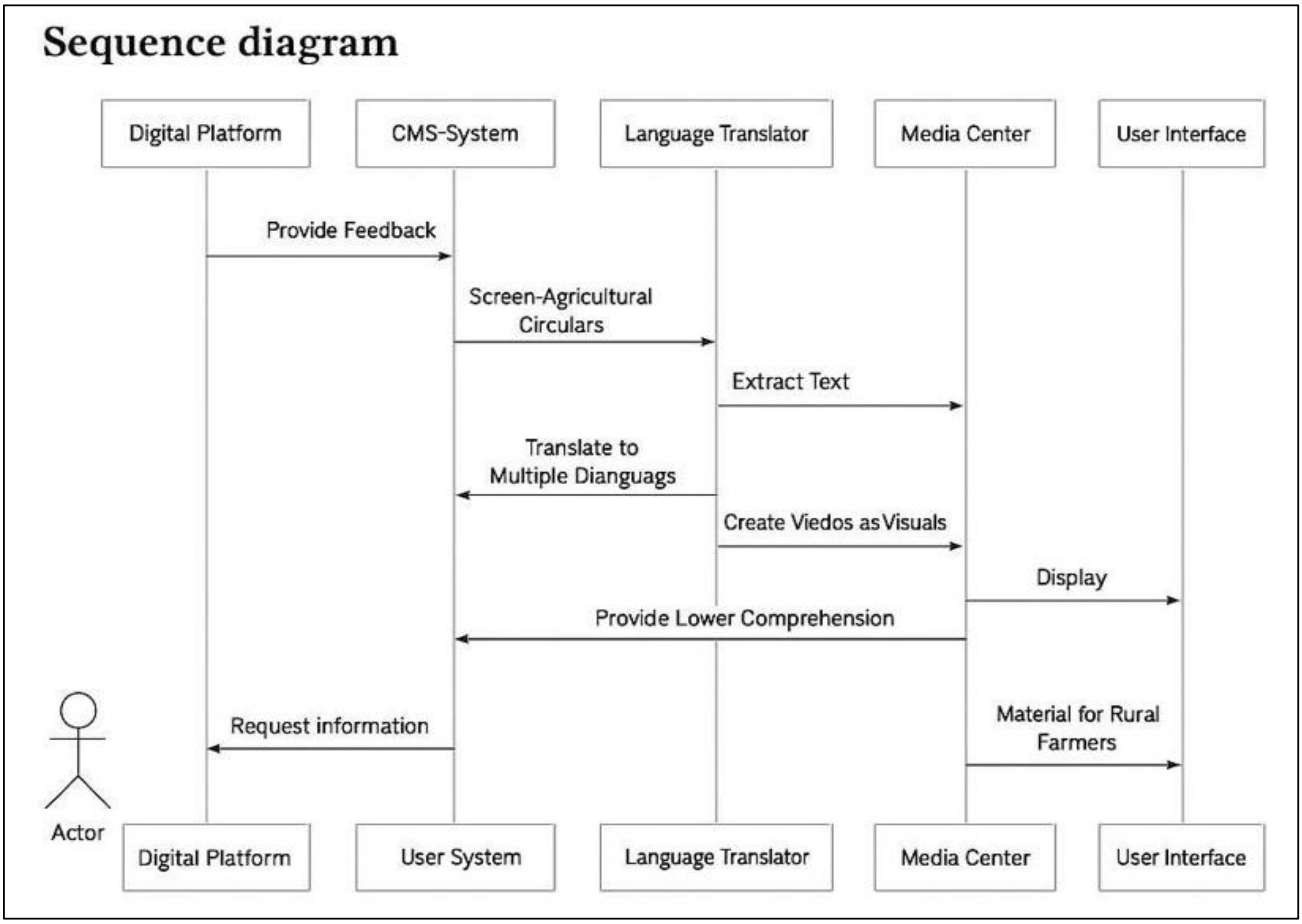

Fig 2 Sequence Diagram Example

V. RESULTS AND OBSERVATIONS

➢ *Preprocessing and Model Training*

The data set was divided into individual training and test sets:

- 80% Training Data: 1,200 circulars were utilized to train NLP and video generation models.
- 20% Test Data: We made use of 300 circulars for testing.

The text processed was cleaned and summarized before its translation into different languages and their conversion into both audio and video formats.

➢ *Comparative Performance of Models*

The system was also compared with other text-based advisory systems and text-to- video automated systems such as Creatomate.

Table 1 Comparative Performance of Text-to-Video Automated Systems such as Creatomate

Feature	Proposed System	Text-Based Circulars	Automated Text-to-Video Tools (Creatomate)
Multilingual Support	Yes	Limited	No
AI-Based Text Simplification	Yes	No	No
Video Generation with Regional Context	Yes	No	No
Offline Access	Yes	No	No
Real-Time Data Integration	Planned	No	No
User Engagement	High	Low	Medium

VI. CONCLUSION AND FUTURE WORK

This research confirms the viability of converting farming circulars into audiovisual material using the MERN stack with Python. By breaking down complex information and making it engaging, the platform empowers farmers with the appropriate knowledge.

➢ *Future Work:*

- Developing an app with offline functionality. With current weather and market information.
- Enhancing interactivity by using quizzes and feedback mechanisms.
- Implementing AI-driven content personalization based

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on user behavior.

- Investigating blockchain-supported data verification to ensure and secure advisory data's integrity.

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