Development of an intelligent virtual assistant for digitalization of Moroccan agriculture

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Abstract. This paper presents the design, development, and implementation of an innovative text-to-text chatbot system aimed at digitalizing the agriculture sector in Morocco, with a focus on supporting Darija-speaking farmers. The project also encompasses the curation of a comprehensive database to facilitate future fine-tuning of Speech-to-Text (STT) and Text-to-Speech (TTS) models in Darija. The project's primary objective is the development of chatbot capable of responding to farmers' text queries in Darija, providing them with instant access to critical agricultural information and support. Concurrently, we have curated an extensive database of Darija agricultural terminology, phrases, and dialogues, laying the groundwork for future voice-enabled interactions. Throughout the project, we have conducted thorough research into Darija linguistics and agricultural practices, followed by an in-depth development phase of the chatbot system. This included natural language processing, intent recognition, and response generation tailored to the nuances of Darija. The database curation involved extensive collaboration with agricultural experts to ensure authenticity and relevance. Looking forward, this project serves as a crucial stepping stone towards a fully voice-enabled agricultural support system in Darija. The curated database will be instrumental in fine-tuning STT and TTS models, potentially revolutionizing how Moroccan farmers access and interact with digital agricultural resources.

1 Introduction

The Moroccan agricultural sector faces significant challenges in balancing traditional practices with the need for modernization to address 21st-century challenges. A major obstacle is the language barrier, as many Moroccan farmers primarily speak Darija, limiting their access to modern agricultural information and technologies. This project aims to bridge this gap by developing a digital platform that provides crucial information and support to Moroccan farmers in their native language.

Agriculture plays a vital role in Morocco's economy. According to the World Bank, as of 2019, the sector employed about 33% of the country's workforce and contributed approximately 12% to the GDP according to World Bank, 2021 [1]. The sector faces significant challenges such as climate change, water scarcity, and limited access to modern farming techniques [2]. In response to these challenges, the Moroccan government launched the Green Morocco Plan in 2008, aiming to modernize the agricultural sector [3]. However, language barriers and limited digital literacy among farmers have hindered its full implementation [4].

Several studies have explored the use of chatbots in agriculture. Jain et al. [5] developed FarmChat, a conversational agent for potato farmers in India. Sawant et al. [6] created AgriBot, an interactive web application using the KNN algorithm and DialogFlow API. Niranjan et al. [7] recommended the use of seq2seq models for agricultural conversational systems. However, these solutions do not address the specific linguistic and cultural context of Moroccan agriculture.

In the realm of Arabic dialect processing, Bouamor et al. [8] created MADAR, a corpus for Arabic dialect identification. Meftouh et al. [9] developed PADIC, a parallel Arabic dialect corpus including Moroccan Arabic.

These resources, while valuable, do not specifically target agricultural vocabulary in Darija.

More recent work by Biswas and Goel [10] has focused on developing intelligent chatbot assistants for agriculture, demonstrating the growing interest in this field. However, their work does not specifically address the unique challenges of the Moroccan context.

2 Methodology

2.1 System Architecture

Figure 1 illustrates the overall architecture of our intelligent virtual assistant system.

2.2 Data Collection and Processing

We collected data from two main sources:

- For chatbot development: Official documents from ONSSA (Office National de Sécurité Sanitaire

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des Produits Alimentaires) and FDA (Fonds de Développement Agricole) subvention documents.

- For Speech-to-Text (S2T) model development: Wescraped content from over 50 YouTube channels, resulting in more than 1700 videos.

Figure 2 shows our data processing pipeline for the S2T model development.

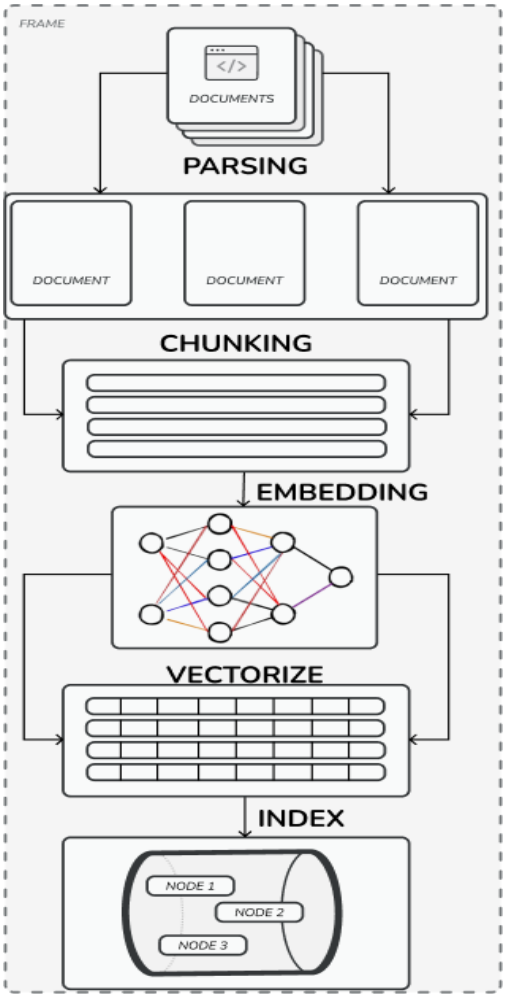

Fig. 1. Architecture of the intelligent virtual assistant system proposed

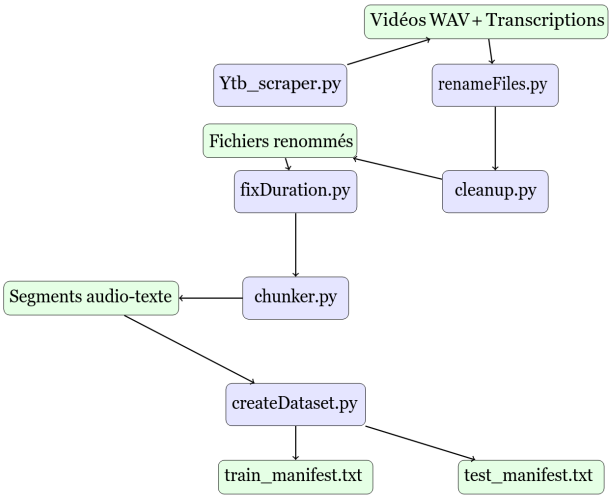

Fig. 2. Data processing process for the S2T model

2.3 Chatbot Development

We utilized prompt engineering techniques to create an effective chatbot persona. The chatbot, named FellahBot, was designed to act as an agricultural expert for Moroccan farmers, capable of communicating in Darija, standard Arabic, and French when necessary.

The chatbot architecture is based on the Retrieval Augmented Generation (RAG) approach, which combines a pre-trained language model with an external knowledge base. This approach is similar to recent advancements in multilingual speech processing, such as the work by Zhang et al. [11] on cross-lingual neural codec language modelling.

2.4 User Interface

We developed a user-friendly interface using Streamlit, a Python framework for creating web applications. Key features include:

- Bilingual interface (Arabic/French).
- Large, clear buttons for easy navigation.
- Text-to-speech functionality for users who prefer audio output.

Figure 3 shows a screenshot of our chatbot interface.

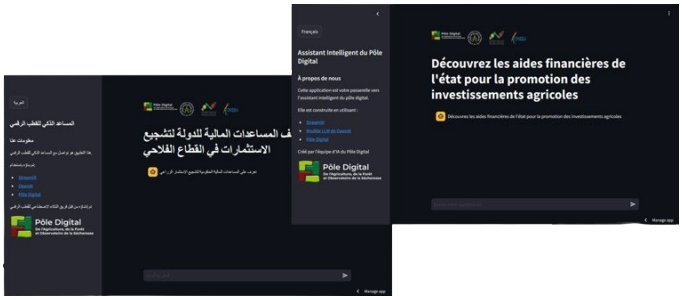

Fig. 3. French/Arabic Chatbot Interface using Streamlit

3 Results and discussion

3.1 S2T Model Benchmark

We conducted a benchmark comparison between SeamlessM4T and Whisper models for Darija speech recognition. Results showed that SeamlessM4T outperformed Whisper, obtaining about 40% of user votes in performance evaluations. This aligns with recent advancements in multilingual speech-to-speech translation, such as the work by Huang et al. [12] on expressive speech-to-speech translation.

Figure 4 illustrates the results of our benchmark tests.

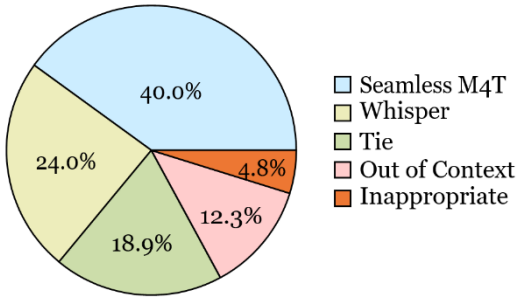

Fig. 4. S2T Models Benchmark results (according to 438 votes)

3.2 Chatbot Performance

The chatbot was tested with over 70 unique users and showcased at the International Agriculture Fair in Morocco (SIAM). Preliminary results showed high user satisfaction rates, with over 80% of users reporting that the chatbot provided useful information.

3.3 Cost estimation

We estimated potential costs for using various AI services, including GPT-3.5, GPT-4, and Whisper. For example, for a user base of 10,000:

- GPT-3.5 Turbo: Estimated monthly cost of 75 $
- GPT-4: Estimated monthly cost of 4,500 $
- Whisper (if used instead of SeamlessM4T): Estimated monthly cost of 1,500 $

3.4 Hardware Requirements

For fine-tuning the S2T model, we estimated the following hardware requirements:

- GPU memory: Approximately 58.25 GB
- RAM: 273.01 GB
- Training duration: About 26.2 hours

These requirements are in line with recent advancements in large-scale speech generation models, such as Voicebox by Le et al. [13].

4 Conclusion and Future Work

This project demonstrates the potential of AI-driven solutions in addressing language barriers and improving access to agricultural information for Moroccan farmers. Future work will focus on continuous improvement of the S2T model, expansion of chatbot functionalities, cost optimization, and measuring the social and environmental impact of the system.
One promising direction for future work is the implementation of efficient attention mechanisms, such as the Efficient Monotonic Multiheaded Attention (EMMA) proposed by Ma et al. [14], which could improve the performance and efficiency of our models.

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