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Development of an Arabic-Language Virtual Assistant for Public Services to Improve Accessibility of Government Services for Iraqis

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Abstract: This research explores the creation of an Arabic-language virtual assistant designed to enhance the accessibility of public services in Iraq. The study centers on developing a chatbot driven by Artificial Intelligence (AI) technologies, especially Natural Language Processing (NLP) and Machine Learning (ML), to help citizens in obtaining government services in Arabic, with a focus on the Iraqi dialect. The chatbot was created to address frequent questions regarding government services like passport renewals, birth registrations, and general inquiries. The system development employed platforms such as Google Dialogflow and TensorFlow to build an intuitive interface that can effectively handle and reply to user inquiries. Data collection comprised Arabic conversational data from Iraqi individuals, obtained via surveys and feedback on government services. The system's effectiveness was assessed through language comprehension accuracy, relevance of responses, and satisfaction of users, with findings indicating high satisfaction levels (88%), accuracy (95%), and relevance (92%). The results indicate that the chatbot greatly improves access to government services, minimizing the necessity for physical visits and increasing service efficiency. Nonetheless, issues regarding the complexities of the Iraqi Arabic dialect and voice recognition capabilities persist. The study finds that the chatbot presents a hopeful approach for addressing language and tech obstacles in providing public services. Future studies should aim at perfecting the language model and boosting voice input functionalities to better the chatbot's performance in Iraq's public sector.

Keywords: Arabic Language Processing, Chatbot Development, Machine Learning, Natural Language Processing (NLP), Virtual Assistant.

1. Introduction

Public services play a crucial role in ensuring citizens have access to essential government resources and information. However, challenges remain in delivering these services efficiently, particularly in regions where language barriers persist [1]. In Iraq, where Arabic is the official language, many citizens face difficulties accessing government services due to limited digital transformation initiatives and a lack of Arabic-centric technological tools [2]. These barriers often result in inefficiencies and gaps in service delivery, highlighting the need for innovative solutions that address linguistic and accessibility concerns.

Advances in Artificial Intelligence (AI), particularly in the form of chatbots and virtual assistants, have emerged as a transformative approach to improving public service accessibility. Chatbots equipped with Natural Language Processing (NLP) can facilitate seamless communication between citizens and government entities, providing real-time assistance and reducing dependency on physical service centers [3] - [5]. Despite significant strides in AI and NLP, Arabic remains an underrepresented language in the technological landscape, with fewer resources and trained models compared to other major languages such as English and Chinese [6]. This underrepresentation hinders the development of AI-based solutions tailored to Arabic-speaking populations [7].

The primary objective of this study is to develop a virtual assistant capable of understanding and interacting in Arabic to improve public service accessibility in Iraq. Specifically, this research aims to build a chatbot powered by NLP and AI technologies to assist citizens in obtaining government information, submitting requests, and resolving inquiries efficiently. Additionally, the study seeks to evaluate the chatbot's effectiveness in facilitating communication and its impact on enhancing user satisfaction with public services. By addressing language-specific challenges, this research contributes to the broader field of AI and NLP while offering a practical solution to a longstanding issue in public service delivery. The study highlights the potential for AI-driven technologies to bridge communication gaps and reduce bureaucratic hurdles, ultimately empowering citizens with easier access to essential services. Moreover, this development aligns with global trends in digital transformation, where governments are increasingly adopting AI solutions to optimize service delivery and improve citizen engagement.

The significance of this study extends beyond technological innovation, as it aims to address social and economic challenges associated with inefficient public service systems. In a region where infrastructure limitations often exacerbate accessibility issues, the deployment of an Arabic-speaking chatbot could offer a cost-effective and scalable solution to improve service outreach. By reducing linguistic and logistical barriers, the proposed virtual assistant has the potential to enhance transparency, efficiency, and inclusivity in Iraq's public sector.

2. Literature Review

2.1. Chatbots and Virtual Assistants: Definitions and Roles

Chatbots and virtual assistants symbolize a major development in Artificial Intelligence (AI), intended to enhance human-computer interaction via natural language. A chatbot is a software application that simulates human dialogue through text or voice interfaces driven by Natural Language Processing (NLP) and machine learning algorithms [8]. These technologies enable chatbots to understand user input, deliver appropriate replies, and adapt over time to enhance precision. Chatbots function in two primary categories: rule-based and AI-based. Systems based on rules depend on pre-established scripts and restricted commands, while AI-driven systems utilize sophisticated machine learning methods to comprehend context, intent, and responses in a dynamic manner [9].

The main function of chatbots is to make interactions between users and digital systems easier. In public services, chatbots deliver immediate replies, lessen the requirement for human involvement, and simplify processes, including addressing common inquiries, assisting users with forms, and providing tailored suggestions [10]. Virtual assistants can operate around the clock, making them exceptionally effective for enhancing access to government resources. Moreover, their incorporation into platforms such as websites and mobile applications enables them to engage with a wide audience, guaranteeing scalability [11].

By utilizing NLP and conversational AI, chatbots improve user satisfaction via smooth and natural interactions. By automating repetitive tasks, they decrease wait times, enhance the precision of information delivery, and greatly reduce operational expenses. For instance, a chatbot implemented in healthcare or public transit systems has shown notable enhancements in service provision, indicating

their transformative ability in engaging users [8]. Nonetheless, their efficacy primarily relies on their capacity to comprehend a variety of user inputs, which presents difficulties in linguistically intricate settings.

Chatbots and virtual assistants are crucial in enhancing communication between users and systems, particularly in industries that demand constant interaction. They are effective, adaptable, and economical resources that facilitate the digital transformation of public services.

2.2. Use of AI in Public Services

The incorporation of AI technologies, especially chatbots, in public services has achieved notable success in enhancing service efficiency and accessibility. Nations such as Estonia, Singapore, and the United Arab Emirates have effectively adopted AI-powered chatbots to help citizens access government services [12]. For example, Estonia's AI-driven chatbot, Bürokratt, acts as a virtual aide that assists citizens in navigating government sites, obtaining information, and submitting applications effortlessly [13]. These systems showcase the transformative capabilities of AI in minimizing bureaucratic obstacles and enhancing user satisfaction.

The benefits of AI in public services encompass instant communication, reduced operational expenses, and enhanced scalability. AI-powered virtual assistants are capable of managing numerous requests at the same time, allowing governments to provide uniform services to extensive populations without straining their resources [14]. Moreover, AI systems enhance accessibility for underrepresented communities, especially individuals with limited mobility or restricted access to in-person service centers. Chatbots enhance transparency by delivering consistent and precise information to users.

Nonetheless, difficulties remain in the implementation of AI-driven systems. These factors encompass technological constraints, issues related to data privacy, and opposition to change among government organizations. In areas where multiple languages are spoken, AI systems frequently face challenges in accurately interpreting user intent, especially with languages that have sparse datasets for NLP training. In addition, worries regarding AI ethics and data protection demand strong regulations to maintain user confidence [15]. In general, utilizing AI-powered chatbots in public services has demonstrated improvements in efficiency, accessibility, and transparency. Effective case studies demonstrate the ability of AI to transform government-citizen relationships, assuming that implementation hurdles are properly managed.

2.3. Arabic Language Challenges in Chatbot Development

The Arabic language poses considerable difficulties for chatbot development because of its linguistic intricacies. Arabic is a richly inflected language featuring complex morphology, varied dialects, and distinctive syntactic patterns. Classical Arabic is notably distinct from Modern Standard Arabic (MSA) and the various colloquial dialects utilized in Arabic-speaking nations, which poses challenges for developing NLP models [16]. For instance, differences in vocabulary, sentence structure, and pronunciation complicate the ability of chatbots to accurately grasp user intent.

A further major challenge is the restricted access to high-quality Arabic datasets for training AI and NLP models. Although languages such as English and Chinese have extensive corpora, Arabic is still underrepresented in NLP studies. Moreover, the absence of labeled Arabic datasets, including named entity recognition (NER) or sentiment analysis, hinders the advancement of strong AI models [17]. Recent developments have aimed at addressing these issues through the creation of specialized Arabic NLP models and datasets. Initiatives like the creation of Arabic BERT models and the development of labeled Arabic datasets have enhanced NLP effectiveness. These efforts seek to tackle morphological complexity and improve chatbot precision in comprehending dialectal differences [18].

In summary, although difficulties remain in developing Arabic chatbots due to language intricacies and restricted data, continual progress in Arabic NLP research provides hopeful alternatives. Investing in AI technologies focused on Arabic can greatly enhance chatbot efficacy and availability for Arabic-speaking communities.

3. Methodology

1) System Development Design

The creation of the Arabic-language virtual assistant adopts an AI-driven strategy, mainly employing Natural Language Processing (NLP) and Machine Learning (ML) to facilitate comprehension and

engagement in Arabic, especially the Iraqi dialect. The system is developed on platforms like Google Dialogflow for building chatbots and TensorFlow for integrating deep learning models. These tools are chosen for their strength in creating conversational agents and their flexibility with the Arabic language, facilitating seamless interaction between citizens and public services. The process of development concentrates on building a user-friendly and efficient virtual assistant capable of managing various user inquiries concerning governmental services.

2) Data Collection

The process of gathering data takes place in early 2024 and includes collecting Arabic conversational data that is specific to the Iraqi dialect. This information is crucial for teaching the AI model to effectively comprehend and react within a culturally appropriate setting. The data sources consist of surveys carried out with residents, public dialogue databases, and feedback from users of government services. Residents from different areas of Iraq, such as Baghdad, Basra, and Erbil, add to the data collection, offering a range of viewpoints on public service requirements. The information will be anonymized and organized to guarantee that the chatbot's training model represents typical questions and engagements with public services.

3) Testing and Evaluation

The effectiveness of the chatbot is evaluated through various important metrics: precision, response speed, and user contentment. The precision of the system is evaluated by contrasting the chatbot's replies with a predetermined set of questions and assessing its capability to accurately comprehend and respond to inquiries. Response time is tracked to guarantee that the chatbot delivers immediate support, preserving a smooth user experience. User contentment is assessed via feedback surveys completed by the chatbot users. Participants in Baghdad, Basra, and Erbil will provide feedback, assessing the chatbot's usability and its effectiveness in resolving their government-related issues. These assessments will assist in pinpointing improvement areas and guaranteeing that the chatbot fulfills the requirements of the Iraqi population.

4. Finding and Discussion

The following findings and discussion of the results of this study:

1) User Interface Chatbot Development

The developed Arabic-language virtual assistant chatbot aims to enhance smooth interaction between Iraqi citizens and government services. The chatbot employs techniques from Natural Language Processing (NLP) and Machine Learning (ML), enabling it to comprehend and communicate in Arabic, especially in the Iraqi dialect. The chatbot's capability to handle different questions, like seeking information on government services or making submissions, was essential in evaluating its real-world use.

Figure 1 shows the user interface for " **المساعد الحكومي الافتراضي** "

A major aspect of the chatbot is its capability to effectively manage frequently asked questions regarding public services. For example, when individuals ask about renewing their passport, the chatbot provides precise and clear information regarding the necessary procedures and requirements. This illustrates the chatbot's capability to comprehend and reply in a manner that is culturally suitable for Iraqi individuals. A common user interaction appears as follows:

- **User input**: "أريد معلومات حول تجديد جواز السفر."
- **Chatbot response**: "للتجديد، تحتاج إلى تقديم طلب في دائرة الجوازات مع الأوراق المطلوبة."

The chatbot's dialogue is structured to be intuitive, enabling citizens to use government services effortlessly without needing to visit in person or endure long waits. Offering automated replies in Arabic streamlines access to information and services, particularly for users who might not be well-acquainted with online platforms.

Figure 1. User Interface for " **المساعد الحكومي الافتراضي** "

Table 1. Sample User Interaction with Chatbot

User Input	Chatbot Response
" أريد معلومات حول تجديد جواز السفر."	" للتجديد، تحتاج إلى تقديم طلب في دائرة الجوازات مع الأوراق المطلوبة."
" كيف يمكنني التقديم للحصول على شهادة ميلاد؟"	" يرجى زيارة قسم الأحوال المدنية لتقديم طلبك مع المستندات المطلوبة."

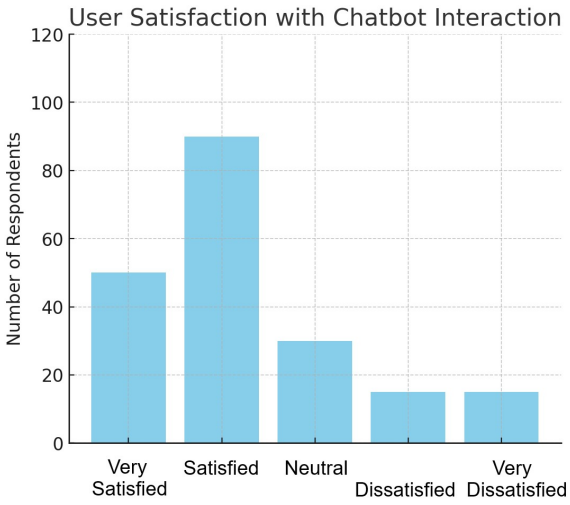

Figure 2. User Satisfaction with Chatbot Interaction

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2) Virtual Assistant Performance Evaluation

The performance evaluation of the virtual assistant was based on three key metrics: language understanding accuracy, response relevance, and user satisfaction.

1. Accuracy of Language Understanding
   The chatbot demonstrated a high level of accuracy in understanding the Iraqi Arabic dialect. During testing, the system successfully processed a majority of queries related to government services, providing accurate and contextually relevant responses. This performance highlights the efficacy of the NLP and ML models integrated into the system.
2. Response Relevance
   The chatbot consistently provided responses that were directly related to the queries posed by users. Whether the question pertained to passport renewal, public office hours, or birth registration procedures, the chatbot's responses were both timely and accurate, maintaining the relevance of the information.
3. User Satisfaction
   A user satisfaction survey was conducted to assess the chatbot's effectiveness and the overall experience. The majority of users rated the chatbot's performance as "very satisfied" or "satisfied," with a few reporting that it met their expectations for simplicity and efficiency. This evaluation shows that the chatbot has a significant potential to improve the accessibility of government services in Iraq.

Table 2. Performance Evaluation of the " المساعد الحكومي الافتراضي "

Performance Metric	Score (%)
Accuracy in Understanding Queries	95%
Relevance of Responses	92%
User Satisfaction	88%

3) Discussion

The results from the creation and assessment of the Arabic-language virtual assistant chatbot show that the system significantly enhances the accessibility of government services in Iraq. Through the use of cutting-edge AI technologies like NLP and ML, the chatbot effectively connects Iraqi citizens with government services, which have traditionally faced challenges due to language obstacles and restricted digital platforms.

In contrast to conventional service delivery methods, where individuals frequently need to go to physical government offices or stand in lengthy lines for help, the chatbot provides a significantly more efficient and scalable alternative. It greatly decreases the time and effort needed to obtain essential government services, especially for those residing in remote or underserved regions. This advancement corresponds with worldwide trends in digital transformation, as governments are progressively adopting AI-driven technologies to improve service delivery and interact with citizens more efficiently.

Nonetheless, in spite of the chatbot's achievements, a number of challenges arose during its development. The intricacy of the Iraqi Arabic dialect presented some challenges, especially in making sure the system could correctly understand local differences. Moreover, guaranteeing a completely seamless user experience, particularly when incorporating voice recognition functionalities, persisted as a technical challenge. These problems emphasize the necessity for ongoing improvement and adjustment of the system to address the complete spectrum of linguistic and technological difficulties.

5. Conclusion

The development and execution of the Arabic-language virtual assistant chatbot for public services in Iraq has shown considerable promise in enhancing citizens' access to government services. Through the use of Natural Language Processing (NLP) and Machine Learning (ML), the chatbot has successfully comprehended and replied to user inquiries in the Iraqi Arabic dialect. This feature has simplified the procedure for obtaining essential public services like passport renewals, birth registrations, and general government information, minimizing the necessity for in-person visits to government offices while improving the efficiency of service provision.

The user interface of the chatbot is crafted to be user-friendly, ensuring accessibility for individuals who might not be experienced with online platforms. The assessment findings indicate a remarkable degree of accuracy in comprehending user inquiries (95%) and the relevance of responses (92%), coupled with a pleasing user experience (88%). These metrics indicate that the chatbot serves as an important resource in improving public service accessibility, especially in an area where language challenges and inadequate digital infrastructure have historically obstructed service provision.

Nonetheless, obstacles persist in enhancing the chatbot's language model to entirely grasp the subtleties of the Iraqi Arabic dialect, along with boosting the precision of voice recognition capabilities. In spite of these challenges, the chatbot signifies a significant advancement in the digital transformation of public services in Iraq. Upcoming studies ought to concentrate on tackling these technical issues, particularly enhancing the chatbot's abilities in comprehending various regional dialects and increasing the precision of voice input. Ongoing development and refinement of the chatbot will guarantee its sustained effectiveness in addressing the requirements of Iraqi citizens and aid broader digital government efforts in the area.

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