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The Role of AI and Natural Language Processing in Developing Tools That Mimic Human Speech

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دور الذكاء الاصطناعي ومعالجة اللغة الطبيعية في تطوير أدوات تحاكي الكلام البشري

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الملخص

أثرت التطورات الحديثة في الذكاء الاصطناعي ومعالجة اللغة الطبيعية بشكل كبير على تطوير ادوات تحاكي الكلام البشري. تبحث هذه الدراسة في كيفية مساهمة تقنيات الذكاء الاصطناعي ومعالجة اللغة الطبيعية في بناء انظمة قادرة على فهم اللغة البشرية وانتاجها والتفاعل معها بطريقة طبيعية وتفاعلية. تسلط الدراسة الضوء على تقنيات مهمة , مثل التعلم الالي والشبكات العصبية ونماذج التعلم العميق, والتي تمكن هذه الانظمة من توليد الكلام بسلاسة ودقة اكبر . كما يتناول البحث الصعوبات التي تواجهها هذه التقنيات, مثل فهم السياق ونبرة الصوت والعواطف والاجزاء غير الواضحة من الكلام البشري. كما تسلط الضوء على الاستخدامات المختلفة لهذه التقنيات, بداء من المساعدين الافتراضيين وروبوتات خدمة العملاء وصولا الى تطبيقاتها في مجالات التعلم والتعليم والترفيه. ومن خلال دراسة التقدم الحالي, والمخاوف الاخلاقية, والاحتمالات المستقبلية, يبين البحث الحالي كيف ان الذكاء الاصطناعي ومعالجة اللغة الطبيعية لديهما القدرة على تحديد كيفية تفاعل البشر مع اجهزة الحاسوب. تم جمع البياتات من ٤٨ طالبا عراقيا يدرسون اللغة الانكليزية في المرحلة النهائية من الدراسات العليا. تم اختيار المشاركين باستخدام اساليب اخذ العينات غبر العشوائية. وتم تحليل البيانات احصائيا باستخدام الاحصاء الوصفي والاستدلالي. تشير نتائج البيانات الى ان الذكاء الاصطناعي ومعالجة اللغة الطبيعية يواجهان تحديات واضحة في ايجاد ادوات وطرق تحاكي الكلام البشري. وعليه توصي الدراسة بان تطبيقات الذكاء الاصطناعي في معالجة اللغة الطبيعية في كل من الاستماع والكلام تحتاج الى مزيد من الاهتمام والمراجعة من قبل المحترفين والمختصين لتطويرها بشكل اكبر لتعزيز قدرتها على محاكاة التواصل الكلامي البشري.

الكلمات المفتاحية: الذكاء الاصطناعي, معالجة اللغة الطبيعية, الادوات, يحاكي, الكلام البشري

Abstract

Recent improvements in Artificial Intelligence (AI) and Natural Language Processing (NLP) have greatly influenced the formation of tools that can imitate human speech. This study looks at how AI and NLP technologies assist to build systems that can understand, produce, and correlate with human language in a way that feels natural and conversational. It sheds light on important techniques like machine learning, neural networks, and deep learning models that allow these systems to generate speech more smoothly and accurately. The paper also examines the difficulties these technologies face, such as understanding context, tone, emotions, and the unclear parts of human speech. It also highlights various uses of these technologies, from virtual assistants and customer service bots to applications in learning, education, and entertainment. By examining current progress, ethical concerns, and future possibilities, the paper shows how AI and NLP have the ability to declare how humans interact with computers. Data were gathered from 48 Iraqi postgraduate students of English language. The participants were chosen using non-random convenience sampling methods. The data were analyzed statistically using descriptive and inferential statistics. The data indicate that AI and NLP have clear challenges in finding tools and ways that mimic human speech. The study's findings recommend that AI

applications in NLP in both listening and speech need more attention and revision by professionals and specialists to be developed more in order to enhance their abilities to imitate human speech communication .
Keywords: artificial intelligence, natural language processing, tools, mimic, human speech

١. Introduction

With the rapid development in different aspects of life, the claim for various functions and tasks of language is expanding increasingly, and accessible and capable online implements have become the most required means of language tasks. These language tasks basically depend on natural language processing (NLP) technology to achieve. Concurrently, the process of NLP development has led to significant modifications in the working way of various fields which considers speech as a basic medium. Mr. Feng Zhiwei, a specialist in NLP argued that, "In the field of artificial intelligence, those who control language control the world". In spite of all the various efforts of technicians and linguists, NLP technology could approach a certain level, however, a great number of linguistic challenges are still available and need serious efforts to overcome. Hence, contemporary linguists are required to make an adaptation to the background of the era of AI. Moreover, linguistic information need to be applied to the different fields of technology and uses of electronic language need to be taken into consideration in the AI application in order to contribute to the development of technology (Zhiwei, 2008). In a related way, the latest increasing use of AI has significantly supported the field of NLP, converting it from a rule-based system to a more dynamic and adaptive model. As a result, NLP has turned to be more efficient, capable of achieving more tasks ranging from translation to sentiment analysis (Springer, 2018).

To understand NLP and AI, the concept of both should be grasped first. Natural language is seen as the language that is formed a long with the process of human culture development, employed by people to communicate with each other, and may change and modify permanently. Languages like Chinese, English, and Japanese are instances of natural languages. Recently, NLP has attracted notable attention for its capacity to exemplify and assess human language computationally. Its demands have proliferated across various fields, including machine translation, email spam detection, information extraction, summarization, medical applications, and question answering, among others. NLP can work when it enables machines to transform input information to humans, helping people to interact with computers employing natural language. Additionally, NLP has two main components: Natural Language Understanding (NLU) and Natural Language Generation (NLG). For NLU, it concentrates on providing computers with the capacity to understand the natural language people usually use, while NLG functions as a data generator that supplies computers with data in natural language format. In this respect, it could be illustrated that a different types of technologies like voice assistants, speech features in chat applications, text generation techniques and machine translation are all based on NLP. Accordingly, an ability of a machine to behave in a way similar to intelligent human is called AI which is also viewed as being the major source of building capable devices related to various computer programs with high quality (McCarthy, 2007). Since AI has its role in improving teaching methods and learning experiences, and speed up administrative functions, it turns to become a very important part of modern educational systems (McCarthy, 2007).

People often use language every day without considering the complex mechanisms behind it, yet articulatory movement, the action of the lips, tongue, and other vocal organs is among the most subtle and efficient activities humans engage in. Human speech is made up of several components: phonetics is the first component which includes how different sounds can be produced and perceived, second is morphology which studies how the smallest parts of words are combined; and then syntax that focuses on the arrangement of words to form sentences. In addition, semantics also has a part in the process of articulation in that it looks at the meanings of words, while pragmatics looks at how context affects our communication. Finally, sociolinguistics studies how language develops within different social groups. All of these elements help us communicate our thoughts and feelings to others (Fitch, 2000). This nuance enriches communication because the same phrases can carry different meanings based on context; different communities may express language differently due to their cultural background, history, and experiences (Lieberman, 2000) .

١,١ The Interconnection between AI and NLP

The interconnection between AI and NLP is of a great significance for creating advanced tools that imitate human conversation, changing how people interact with computers. These technologies help machines understand, create, and use language in a way that feels smooth and natural. They improve communication by

analyzing and enhancing text, which is essential for clear exchanges. This idea is boosted by the ability to give coherent responses that consider context, leading to more engaging conversations. Advances in speech recognition and text-to-speech technologies allow these systems to change spoken language into text and vice versa, making conversations feel more real .

NLP is a specialized area of AI that aims to allow machines to comprehend, interpret, and can imitate certain kind of language similar to that of humans. NLP is utilized in various applications, including text classification, machine translation, and question-answering systems. To assess and understand extensive datasets of natural language, machine learning algorithms, especially deep learning, are frequently applied in NLP, positioning it as both an application and a vital facet of AI research (Eisenstein, 2019). NLP is mainly employed to enable machines to understand and imitate the natural human language. According to Liu et al. (2023), NLP is used to enable machines to understand the process of the natural human language and NLP communications assist machines have become convenient. In addition, the main function of AI is its ability to analyze and assess the provided information. As a result, it can produce language similar to that of humans and accordingly can improve the smoothness and intuitiveness of interactions (Liu, 2023).

Various issues related to the use of NPL were found out through the investigation of previous literature. Dreisbach et al. (2019) identify that efficiency is considered as the main factor which influence the accurate performance of NLP. Further, ROI is viewed as being an important part that requires to be considered when NLP has to work. Further, since NPL forms are currently developing, there is a possibility of a certain kind of risk related to the work of these types of technology like NLP. (Dreisbach, 2019).

١،٢The Main Applications of AI in NLP

The use of AI in the processes of natural language has widely increased in the last few years. AI has extensive applications in various fields ranging from machine translation to different classifications of texts and machine learning. The application of AI methods in NLP has created various domains which require understanding and imitating human language.

١،٢،١Virtual Assistants

The combination of AI, NLP, and machine learning (ML) as being advanced technologies has turned to be so important to enhance and improve the quality of online services (eservices) on e-commerce platforms (Lin, 2020; Khrais, 2020; Ardiyanto, 2023). Such type of technologies does not only improve the efficiency of such applications but also significantly enriches user experience, participating in higher customer satisfaction and loyalty (Khrais, 2020; Maqsood, 2021; Kalia, 2021; Mah, 2022). Since consumers increasingly tend to purchase from online supplies taking into consideration convenience, efficiency, and personalized experiences, the significance of AI, NLP, and ML in transforming e-commerce is more pronounced than ever (Srivastava, 2021; Song, 2019). Supported by a range of computational techniques, AI has introduced serious changes to many industries accompanied with e-commerce as being a primary beneficiary. Accordingly, AI algorithms assist e-commerce platforms to make an analysis for large datasets, hypothesize consumer behavior, and suggest personalized recommendations (Lin, 2020; Gochhait, 2020; Vivek, 2022; Carvalho, 2019). This personalization can correspond with customer satisfaction by offering tailored product suggestions, which increases purchase likelihood and establishes a more engaging shopping experience. Furthermore, AI-powered chatbots and virtual assistants are changing customer service by providing instant, accurate, and personalized responses to customer queries, greatly reducing response times and enhancing service quality (Lin, 2020; Gochhait, 2020; Vivek, 2022; Carvalho, 2019).

Since NLP is a branch of AI which focuses on the interaction between computers and human language, it is used in e-commerce to helps e-commerce platforms to understand, interpret, and respond to customer questions in specific time. The employment of NLP in businesses helps experts analyze customer reviews, feedback, and social media interactions to obtain valuable insights into consumer preferences and pain points (Sun, 2022; Kulkarni, 2022; Kashyap, 2022). Such employment is essential for improving product offerings, enhancing customer service, and developing targeted marketing strategies. (Ardiyanto, 2023; Bahja, 2020; Papenmeier, 2021; Xu, 2024) .

١،٢،٢Customer Service Bots

The use of AI, NLP, and ML together in e-commerce does not only improve e-service quality but also states the challenges and difficulties related to scalability and personalization (Maqsood, 2021; Agarwal & Jayant, 2019; Chinenye, 2022; Micu, 2021). Because e-commerce platforms make it difficult for volumes of transactions and customer interactions to increase, these technologies offer scalable solutions that maintain high service levels. For instance, AI and ML algorithms have the ability to process and analyze a large number of datasets in real-time, ensuring that personalized recommendations and dynamic pricing adjustments are made quickly. In a similar way, NLP makes it easy for seamless to be communicated between customers and platforms, facilitating quick resolution of issues and enhancing the overall satisfaction of the user (Maqsood, 2021; Agarwal & Jayant, 2019; Chinenye, 2022; Micu, 2021).

١,٢,٣Machine Translation .

With the development of NLP, significant changes have been brought in the working field of translators in the current times. In the current time, translation profession mainly depends on the interaction between translators and machines in that these machines have a significant role in the translation process. Machine translation, therefore turned to one of the main applications of NLP. As the quality and efficiency of machine translation showed a significant improvement, statistical machine translations have taken roles in neural machine models that are viewed to be capable of capturing the nuances and context of language effectively (Sharma et al.). The relation between learning and machine translation is obvious that the application of deep learning in machine translation does not only enhance the quality of translation but also facilities the speed of the translation process. This could make real- time translation more feasible. Accordingly, wide applications for different sectors are employed, such as international business, healthcare and emergency response services

)Springer, 2018.(

١,٢,٤Learning Bots

It is important to highlight that AI is a powerful technology that can be used to improve language learning for students of different ages and various skills . AI can help learners learn a new language more quickly and effectively by providing personalized learning, real-time feedback, flexibility, access to resources, and cost-effectiveness. (Suryana et al., 2020). It could be argued that AI deals with some of the biggest problems like changing teaching methods and supporting the achievement of SDG 4. However, the fast growth of technology always comes with risks and challenges. With the help of AI technologies, the Education 2030 Agenda can be reached and achieved, and UNESCO is directed to helping Member States do so while making sure that its use in educational settings is guided by the main values of fairness and inclusion. (UNESCO, 2019). Accordingly, AI has the ability to totally change how English is taught and learned. In fact, students can learn languages more effectively with the help of AI. Moreover, it could be said that though research on AI's usefulness in education is still in its early stages, the early findings are promising. (UNESCO, 2019).

As illustrated by Suryana et al. (2020), AI was used to enhance another important skill. Their study examined how students responded about the use of mobile AI applications to improve the students' listening skills in English. It was qualitative research done through a WhatsApp online interview. The sample consisted of five students ; two male and three female psychology majors. The study tried to find out how participants reacted about different artificial intelligence mobile applications, including TuneIn-NFL Radio, Free Music, Sports & Podcasts, Netflix, Joox Music, and VOA Learning English and Listening every day which lead to develop listening skill. (Suryana et al., 2020).

١,٢Statement of the Problem

In spite of the notable progress in AI, especially in NLP, it is believed that it still encounters real and serious challenges, such as accurately capturing speech with different accents, dialects, and in noisy environments, as well as generating speech that appears natural, emotionally nuanced, and contextually appropriate. It has been found that it is extremely challenging to grasp the complete context of conversations, which results in irrelevant or incorrect replies. Despite the improvements in multilingual functionality, AI systems still have difficulty navigating various languages and cultural subtleties with fluency. These limitations hinder the effectiveness of artificial intelligence in practical uses, such as virtual assistants, customer service, and accessibility tools.

The use of AI systems across various sectors requires a lot of power and computational energy, raising concerns about sustainability and environmental impact. Developing more efficient algorithms and leveraging advances in hardware to reduce the carbon footprint of AI technologies is an ongoing challenge. The present study hypothesizes that current AI models often struggle to understand idiomatic expressions, slang, and

regional differences in language, which can lead to misunderstandings and miscommunication. Another major issue is the ethical and privacy concerns surrounding AI-based speech technologies. An important problem to solve is making sure that these systems handle sensitive and personal data responsibly without compromising user privacy.

Since human language is dynamic and constantly changing in terms of vocabulary and use patterns, AI models must be updated and trained on a regular basis to remain applicable and efficient. The complexity and cost of maintaining these systems are increased by their ongoing need for adaptability, and the broad adoption of AI technology depends on user approval and confidence. It's still quite difficult to create AI systems that are trustworthy and easy to understand. For AI and NLP systems that accurately replicate human speech and interaction to be developed and used, these issues must be resolved.

١,٣Objectives of the Study

The present study tries to achieve the following objectives

.١To find out how AI and NLP can work together in order to build systems that mimic human speech .

.٢To examine the extent to which AI and NLP can replicate human speech in conversational contexts.

.٣To examine the difficulties that hinder the application of AI in NLP to enhance a natural speech communication .

١,٤Significance of the Study

This study clarifies that the role of AI in NLP to build tools that mimic human speech is very important because it addresses key problems in helping AI interactions to be more natural, emotionally detailed, and suitable for different situations. It is hypothesized that finding solutions for the difficulties of understanding different accents and dialects, reducing computer power and energy use, and keeping constant updates will participate in improving communication technology, bridging language barriers, and building user trust. The present study focuses on the ethical use, sustainability, and adaptability in a quickly changing language landscape. Hence, it could lead to more effective and trustworthy AI systems for various practical uses.

.٣Data Collection

٣,١Sampling

The data were collected using nonrandom convenience sampling consisting of 48 postgraduate students studying English language in their final stage. The study most commonly uses the nonrandom convenience sampling technique, although it is not the most favored approach for data collection, especially at the postgraduate research level (Dornyei, 2007). This sampling method offers the researcher willing participants, a comprehensive dataset, and facilitates the collection of necessary data (Miles & Huberman, 1994; Dornyei, 2007). The participants were provided with a listening script including four different audios and a questionnaire to collect their responses. Each audio sample consisted of one paragraphs. The four audios provided the researcher the opportunity to identify the exact ability to show naturalness, expressiveness, intelligibility, intonation and voice quality. Each audio sample was repeated twice before it was evaluated by the participants according to the questionnaire .

٣,٢Instruments

This paper employed a method for collecting quantitative data. Four audios were selected and included the same passage. For the audio to be recorded, the software Speechelo was employed. Speechelo is an AI- enabled TTS and voiceover (Blaster Online, 2023). Two of the audios were recorded by a male and female human, native British speakers. The other two audios were recorded by a male and female AI voice using Speechelo. The participants were given five minutes to listen to each audio using supplied headphones which were wirelessly connected to a specific audio system to avoid any possible interference with participants' speech or answers. After each participant listened to all the audio samples, each participant was asked to answer the questionnaire which was based on a rubric evaluation. The questionnaire included questions in which the participants were asked to rate the audio quality according to a) naturalness, b) intelligibility, c) expressiveness, d) intonation and e) voice quality. The questions of these criteria were ranked on a 5- point Likert scale that ranged from 1 (Very bad) to 5 (Very good). Data were evaluated by using a Mean Opinion Score (MOS .(

٣,٣Procedures

The data collection process involved several key steps. First, an appropriate text was selected to create the audio recordings. The text was selected according to certain criteria: First because it is copyright free, and second

because it is being flexible to be analyzed. Then, the researcher had to choose two AI audios from several ones. The selected AI audio were not modified although Speechelo allows the user to add some modification such as, pause or breathing. In addition, two human voice audios were also selected and each audio was read by the speakers. And their voices were not recorded without any change .

In addition, a questionnaire was designed to collect the participants' responses in the respect of the difference between human speech and AI speech. In the first part, the questionnaire included questions about participants' demographic information, their perception and evaluation of audio quality of the four audio samples provided to them. The researcher provided written questions in the questionnaire and the participants were supplied with headphones to listen to the audios before they had to answer the questionnaire. They were given five minutes to listen to each audio among the eighth ones. Then, they were given 20 minutes to answer the questionnaire .

٣،٤Data Analysis

The data was analyzed using both descriptive and inferential statistics. Descriptive statistics, such as frequencies and percentages, were calculated to evaluate students' responses to the questionnaire. As explained earlier, the questionnaire comprised three parts. The first part included the participants' demographic information whereas the second part gives a summary about the main features and the participants' ratings of the audios they listened to according the evaluation criteria. The third part included questions on the participants' perceptions of the audios used in the study .

٣،٥Results and Discussion

The following summary of the results shows the main findings of the study. The first section includes the participants' demographic information. The second summarizes the main features and their ratings. Finally, the third section exhibits the participants' general perceptions of the audios .

Participants' demographic information

Of the 48 participants who participated in the study, 27 (56.25 %) were females and 21 (43.75 %) were males. Among the 48 participants, 37 (77 %) reported that they were between 22 to 29, while 8 (16.7 %) were 30 and 37. Three only (6.3 %) reported that they were between 38 and 45. All the participants were native Iraqi Arabic speakers and postgraduate students studying English as a foreign language in their final stage.

Participants' voiceover rating toward criteria

Five criteria of evaluation were chosen to analyze the participants' perception and rating of each audio. The process of rating was accomplished after the participants listened to each audio and used a five-point Likert scale.

Table 1 shows a summary of participants' rating of each criteria, score means of raw data and percentage .

Table 1 Participants' ratings of each criterion, means of raw data and percentage

Rubric criteria	Description	Female AI	Male AI	Female Human	Male Human
Naturalness	(strained- natural)	37 (62 %)	33 (55 %)	52 (87 %)	54 (90 %)
Intelligibility	(not-understandable- understandable)	45 (75 %)	42 (70 %)	47 (78 %)	49 (82 %)
Expressiveness	(does not convey emotion- conveys emotion	33 (55 %)	29 (48 %)	48 (80 %)	44 (73 %)
Intonation	(monotonous- varied)	36 (60 %)	37 (62 %)	53 (88 %)	54 (90 %)
Voice quality	(unclear- clear)	46 (77 %)	48 (80 %)	55 (92 %)	51 (85 %)

Table 1 explains that some criteria show more contrast, while others are more similar in terms of similar features. According to the participants' responses, some criteria scored higher and lower marks overall. For instance, intelligibility (not-understandable- understandable) (75 %) and voice quality (unclear- clear) (80 %) were the highest for AI voices. In the case of human voices, naturalness (natural- strained (90 %) and intonation (monotonous- varied) (90 %) were the highest. This indicates that overall voice quality (unclear- clear) was the characteristic that appealed most to participants. On the other hand, AI voices ranked the lowest in expressiveness (does not convey emotion- conveys emotion) (48 %) and naturalness (strained- natural) (55 %). It could be said that intelligibility and expressiveness were the characteristics that participants found more unappealing.

In addition, participants were asked about the challenges they encountered when listening to the audios. The first question asked participants if the overall audio quality (background noise or music, static, etc.) had ever increased the difficulty level of an audio imitating to humans speech. Most participants answered affirmatively (83 %). Five participants (10.7 %) stated that overall quality had not been an issue. Only three participants (6.3 %) did not remember any event where overall audio quality had not been an issue. The second question asked the participants whether the speaker's voice (accent, volume, speed, etc.) had ever increased the difficulty of an audio understanding. Most participants (81.3 %) answered affirmatively. Seven participants (14.5 %) answered that this has never been an issue. Only two participants (4.2 %) explained that they do not remember any instance where the voice quality hindered their understanding. The findings state that the participants do not always consider that audios are appropriate for ESL setting.

Moreover, the strengths and weaknesses of each audio were a recurring theme in the responses to the optional, opened question. Some participants responded that female and male AI audios sound like a kind of robotic sometimes, but it's acceptable enough.

Some participants also answered that the audio is clear but the voice is too robotic, and does not sound natural. For them, this was found in female and male AI voice. Additionally, one of the students declared that one of the male human voices seems to be pleasant and feels rushed and even though it certainly has emotion, it's not necessary to be generally happy nor too excited. It's very fluent yet it feels like some air is necessary in order to continue the reading .

Conclusion

This study examines and contrasts the tools that could be developed by AI and NLP in imitating the human speech. So, it aims to find out how both AI and NLP can employ the available tools to communicate like humans. Moreover, the study tries to examine the challenges and difficulties which could hinder the application of AI and NLP to communicate naturally. Based on the findings of the study, a number of conclusions can be drawn. First, AI voices are still not at the same level as human voices though there is a clear progress in the process of using AI technologies in NLP. In general, it could be argued that human voices and speech are preferred over AI speech. However, AI voices, in some uses, can be approaching to the human voices. That is why some participants did not recognize that they were listening to a non- human voice, even though human audios were recorded by experts. Additionally, AI voices cannot be used in all contexts. For instance, AI and NLP applications do not have the ability to some types of interactions and discussions just like human voices and speech. On the contrary, human voices have various interactive communications. Yet, AI voices have specific uses in the absence of human voices in cases in which support is required for visually impaired and distorted brain students and learners. AI and NLP are also required for additional and more precise explanation in some educational contexts .

Second, AI voice and then the applications of AI and NLP are used more in some areas. For this, people who program AI applications could adjust and modify in order to find the most suitable and best applicable technologies. The application of AI could be also required in areas and situations where human voice and speech is difficult to be accessed .

According the findings of the present study, it is recommended that AI applications in NLP need more attention and revision by professionals and specialists in order to develop the tools related to listening and speech. The participants' responses shed the light on the importance of the listening instruction, found the weaknesses and difficulties faced by them when recognizing the AI voices and human voices. It is important for experts to follow a systematic revision of the policies and approaches used currently in administrating AI applications in the speech communication .

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