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PAPER

Mobile/VR/Robotics/IoT-Based Chatbots and Intelligent Personal Assistants for Social Inclusion

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ABSTRACT

Chatbots are dialogue systems that utilize computational linguistics (CL), including automatic speech recognition (ASR) and natural language processing (NLP). Artificially intelligent conversational agents combine personalization, interoperability, and scalability with the aim of promoting safe information monitoring, management, and retrieval. AI chatbots offer user-friendly engagement for innovative e-learning, care assistance, and multilingual digital content creation, promoting inclusiveness and AI-enhanced communication. They are a breakthrough for future societies and economies as they can offer cost-effective, tailor-made, and instant exchange of knowledge and skills, including on-site assistance, health monitoring, and e-consultation. AI chatbots are constantly improving to the benefit of their users. Their economic and social impact is expected to rise as individuals, especially vulnerable populations, are trained to use them for lifelong learning, decision-making, and problem-solving.

KEYWORDS

chatbots, IPAs, natural language processing (NLP), Industry 4.0, social inclusion

1 INTRODUCTION

In contemporary times, artificially intelligent models and humans need to work together towards Industry 4.0 and the 17 United Nations Goals of Sustainable Development by 2030. More specifically, it is of utmost importance that less experienced and marginalized internet users, such as young people, women, refugees, and migrants, receive training in retrieving and managing information via the Internet [1–4].

Chatbots can be utilized in informal, self-directed integration programs for refugees and migrants by creating customized language learning applications. These applications can incorporate games, multiple-choice exercises and real-life scenarios, all tailored to the learner's native language [5–6].

In general, conversational agents can be used to support all informative automated services due to their ability to store data and guide a structured

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conversational flow [7]. Chatbots are used to serve local, national and international organizations, such as the Centers for Disease Control and Prevention, local and federal governments, as well as the World Health Organization and UNICEF. Their merits range from the low cost of use to their scalability and interoperability [8]. Research has shown that patients may exchange much more health information while talking to humanoid robots than to interlocutors [9].

Chatbots analyze context by breaking down input data into keywords to understand the user's request (natural language understanding). The chatbot is developed to perform three actions: respond with simple messages, gather necessary information, or make external API calls. More specifically, the bot can retrieve information from an external application and generate a coherent response in natural language. Therefore, the bot determines the source of its response based on its architecture and the user's request [10].

By 2025, almost 40 percent of the people living in the least developed countries will have access to the Internet [11]. By 2016, nearly 97% of the global population had access to a mobile phone, with a significant portion owning smartphones. Therefore, more than 84% of the world's population is using mobile broadband services. As a result, mobile platforms and mobile-friendly interfaces and designs are common strategies in many training programs.

Chatbots offer cost-effective, flexible, accurate, multilingual, and multi-purpose conversational contexts. They can be used for information retrieval and training in a particular skill. However, regular one-on-one mentoring, group seminars and workshops with trainers are still indispensable [12]. Chatbots can also complement an AI cognitive system to enhance smart and inclusive game-based learning environments [13].

2 MOBILE/WEB-BASED CHATBOTS

Mobile chatbots are technological innovations that minimize the need for personal health caregivers. They can also offer systematic, proactive health education to the general public, overcoming individuals' economic and social limitations. Moreover, mobile chatbots can assist in delivering personalized learning and informative content, creating a democratized society where all citizens have equal access to knowledge and skills, regardless of their background in knowledge or language [14–15]. Certain examples of mobile chatbots include:

Anxiety and depression chatbot applications, which are available for free installation and use on Google Play Store and Apple Store. These apps aim to enhance the accessibility of low-cost self-care options for mental health. The applications are used in interventions related to proactive professional mental health treatments, including mindfulness, mood tracking, meditation and functional assessments [16–18].

Moreover, mobile chatbots can assist as a screening tool to detect non-standardized use of medication and insufficient physical activity [19], in conjunction with cognitive behavioral therapy (CBT) interventions [20], and healthy lifestyle recommendations [21]. Furthermore, chatbots encourage personalized training by enabling the collection and storage of diverse information in an information unit. They are accessible via social media and formal websites [22].

Higher education can also benefit from the use of web-based chatbots for autonomous, advanced, and beginner language learning. The advantages of chatbots lay on real-time interaction, ease of use, and personalization. Students' learning gains stem from improvements in grammar, listening, and writing skills as well as the implementation of 21st-century skills in everyday classroom activities [23–24].

Chatbots have also effectively supported individuals with autism in well-being care, providing both support and emergency assistance [25–26]. Furthermore, proactive health empowerment chatbots can be used for the prevention of psychological stressors among young individuals [27–28].

In another case, the chatbot was used to assist adults in quitting smoking. Its functionality was structured in multimedia formats, such as videos and games. It provided patients with interactive professional treatment for cognitive-behavioral issues and offered training in problem-solving skills. The services are tailor-made according to each patient's unique profile related to self-management skills [29].

In another case, the Chatbot was used as an interpreter. More specifically, the chatbot was used as a contact point between the user and the government services through speaking or typing [30]. Likewise, there is a chatbot in India called "Jugalbandi" that provides access to public digital services in the local language. Users can interact with the chatbot by sending a text or an audio message to a WhatsApp number as a prompt for the bot. The message is transcribed into English by a governmental text-to-speech recognition model as well as by the reasoning models of the Microsoft Azure OpenAI Service. The chatbot retrieves information, which is then synthesized by the text-to-speech model and sent back to WhatsApp in Hindi for the citizen who requested the information. Therefore, the bot surpasses language barriers and delivers accurate information in a dependable and convenient manner for all users. The bot covers a range of public sector services; including agriculture, government financial assistance programs, scholarships, requirements for applying for driver's licenses, medical information, and court documents [30].

Furthermore, chatbots have been incorporated into tutorial systems [31] as well as language learning systems, such as HALEF [32]. In addition, chatbots can operate as learning tools and applications designed and developed either as AI Cognitive Systems [33–34] or rule-based systems for vocabulary and grammar practice [35–37].

3 ROBOTICS AND INTELLIGENT PERSONAL ASSISTANTS

Natural language processing (NLP) and text-to-speech functionalities are increasingly essential to meet the growing demand for personalized and efficient services in the labor market. More specifically, there is a wide range of research on social robotics and their impact on training and socializing with children diagnosed with autism spectrum disorder (ASD) [38–40].

Furthermore, the embracement of human-AI friendship is technologically driven [41]. Such companionship bots are widely used in China and India. They maintain a rigorous profile of registered users and incorporate advanced conversation maintenance mechanisms. Social bots utilize artificial neural networks to enhance the flow of conversation. Also, a personalized conversation based on the user's background and interests creates opportunities for informal language learning [42–43].

Intelligent personal assistants (IPAs) are AI-based voice dialogue systems designed for subscribed services. However, voice recognition is inflexible to each learner's command of a language or its variations, such as dialects. Nevertheless, a number of studies have demonstrated that IPAs are useful for language learning, especially for novice learners of foreign languages [44–46], as well as for writing and storytelling [47].

Moreover, large language models (LLMs) are AI systems that analyze vast datasets to develop artificial neural networks capable of generating texts in a wide range of styles and tones [43]. This is the case of ChatGPT, which has integrated vast

databases, enabling the system to learn languages [48], engage in storytelling, and generate text [49]. Also, another language learning system was developed by extending a LLM called XLNet, which generates feedback based on the opportunities and constraints of specific social settings [50].

It is worth noting that a non-standard technique for parsing a learner's language is to normalize the language as much as possible before processing [51]. Such a parser can combine multiple backend systems with the aim of determining the learner's language [42].

4 INNOVATIVE CONVERSATIONAL AGENT FOR HEALTHY AGING AND SUSTAINABLE LIVING

Recent social crises, such as the COVID-19 pandemic, highlight the importance of resilience and social responsibility as essential skills for the survival of humankind. Moreover, resilience, adaptability, and inclusiveness are irreplaceable skills needed in work environments and in society as a whole [52].

Crucial parameters for social inclusion include healthy aging and sustainable living conditions. The nine-layered model of giftedness includes an innovative theory that explores cognition and emotions, incorporating self-consciousness as a top-level cognitive and mental state. According to this model, lifelong training of cognitive and metacognitive skills, combined with the development of other personal characteristics such as volition, perseverance, wisdom, and prudence, has an impact on individuals' cognitive and mental capacity. The current model has been integrated into a chatbot that offers a personalized learning experience aimed at promoting cognitive and mental health, as well as sustainability and inclusiveness.

Furthermore, the suggested chatbot represents a well-illustrated, interdisciplinary overview of cognitive improvement and brain health as it integrates neuroscience, philosophy, economics, education studies, and information and communication technologies (ICTs). It initiates a new meaning in the terms "intelligence" and "consciousness" and can promote personal and social values, such as self-improvement in the fields of public health, politics, business and education. Moreover, the current digital tool is designed using the Dialogflow Framework, which includes speech-to- text conversion, NLP, database queries, and Google Cloud Platform (GCP) API calls. Furthermore, the Dialogflow Agent uses training data, such as intents, intent training phrases, and entities, to build machine learning models. The agent is also accompanied by data analytics on the premises that the GCP services are used.

In addition, the architecture of the tool offers a customized user experience by incorporating a comprehensive menu that integrates the 21st century skills outlined in the European Skills Agenda (European Commission) with the Sustainable Development Goals set by the United Nations for 2030. More specifically, the app offers users the capability to take a test that assesses their cognitive and metacognitive skills to provide recommendations on their training needs. Therefore, the app provides users with feedback on navigating a route by following a thread of replies [53–54].

The chatbot introduces cognitive and mental processes as well as theories of personality that encompass values and self-beliefs, all intertwined to constitute the construct of giftedness. Therefore, gifted individuals have realized the importance of being global citizens who respect human rights, act with equity and peace in mind, and view environmental protection as a personal responsibility. Thus, as a global citizen, I believe in diversity and social sustainability as tools to combat

racism, discrimination, and violence. The current application was designed to have a strong impact on society and social inclusion by prioritizing lifelong learning for self-improvement and self-awareness, thereby promoting healthy aging and sustainable living [55–56].

5 AUGMENTED REALITY CHATBOTS

An augmented reality (AR)-based chatbot system was developed to provide a stimulating educational environment, offering increased opportunities for exploratory learning experiences. The current chatbot consists of AR technology and the Messenger Chat Software, along with a module for page design and messaging functions. The chatbot promotes autonomous learning after class through mobile devices and any web-based system, aiming to enrich secondary school children's biology education [57].

Another mobile app that utilizes a chatbot in a virtual reality (VR) environment without VR glasses is called "Let's Date!" It was developed to establish an immersive learning environment and enhance students' foreign language competencies [58–59].

A chatbot can also enhance the interface of an industrial design application related to engineering and manufacturing. The chatbot, in combination with an immersive VR human-computer interface and VR headsets or computer screens, forms an interactive and multimodal digital tool [60].

Another study indicated that Generation Z consumers expressed high satisfaction with their shopping experience when utilizing a chatbot integrated with an augmented reality application [61]. E-commerce, with the support of chatbots, offers realistic and immersive experiences. Chatbots simulate conversations with virtual characters, incorporating social aspects into shopping experiences [62].

Therefore, focusing on the implementation of chatbots in applications and smart learning environments, accompanied by the promotion of the young population's level of entrepreneurial and digital skills, can be a breakthrough in the quality characteristics of e-learning, inclusive education, and employability [63].

6 CONCLUSIONS

Chatbots can provide personalized services by customizing the display of information and providing tailor-made interactions based on their users' interests and needs. More specifically, AI models in conversational agents are capable of providing personalized assistance and proactive healthcare while promoting hybrid learning and training environments. More specifically, lifelong learning is an indispensable set of skills that are related to empowering individuals to deal with technological advancements. Inclusive and secure societies require upskilling and reskilling socially vulnerable populations, such as the elderly, youth, women, immigrants, and the unemployed, to adapt to digital transformation.

AI-based tools, including chatbots and intelligent personal assistants are accessible and convenient to use because they are voice-activated and already available on watches, glasses, car installations, and home appliances. AI tools and the Internet of Things, in combination with broadband internet connections and 5G systems, are the technological enablers of social inclusion [64].

The technology behind chatbots includes NLP, functionalities, and machine learning [65]. Generative AI technologies can be utilized as inclusive learning and

training tools [66]. Moreover, such digital tools can lead to students developing multilingualism, critical and creative thinking, collaboration, communication, and problem-solving skills, which comprise 21st century skills. Therefore, AI technology enhances students' learning [67–69] by utilizing either state-of-the-art platforms and programming languages [70] or by implementing smart technologies for learning and teaching [71–72].

In general, AI chatbots are personalized, engaging, and on-demand digital assistants in the fields of e-learning, public administration, and proactive public health surveillance [73]. AI chatbots are low-cost contributors to social inclusion, as they help reduce costs on the state budget and save resources [74–75]. However, users need to possess digital skills to prevent the spread of fake news and misinformation [76]. Moreover, AI chatbots have a positive influence on e-commerce, thereby enhancing the use of mobile devices for local economic development and promoting entrepreneurship and employability in both developed and developing countries [77–78].

Finally, all digital technologies in the field of inclusive education support social inclusion by providing new techniques for effective memory retention, transparency, as well as innovative teaching and learning practices. Additionally, technological breakthroughs, such as virtualization, mobilization, and AI, can create metaverse worlds for knowledge representation and information flow. More specifically, mobile devices facilitate and enhance the processes of inclusiveness through the diffusion of educational activities worldwide [79–80], in combination with a variety of ICT applications in assessment and intervention, which are the main drivers of education [81–82]. While games transform education into a multimodal and enjoyable interaction, the integration of AI, STEM, and robotics elevates educational practices to high levels of adaptation, creativity, and efficacy [83–85]. Furthermore, ICTs integrated with the new models of giftedness, metacognition, emotional intelligence and consciousness [86–97] prioritize the enhancement of mental abilities within educational processes and policies. This integration also accelerates and enhances inclusive practices within society.

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