A Chatbot-based Assistive Technology to Get Information on a Clinical Environment

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ABSTRACT

Healthcare is crucial for our society. Nowadays ICT has revealed the potential of improving efficiency and lowering costs. Chatbots interact with humans to answer questions, provide information and suggestions, and even in more complex tasks, such as assisting clinicians in performing diagnoses. However, despite their steadily increasing importance, only very few chatbots are created with inclusivity in mind, in order to be easily exploited by anyone, regardless of abilities. In this study, we propose a chatbot-based assistive technology for providing usable content with immediate short and focused answers. The basic idea that has driven the chatbot design was to provide an assistive technology capable of giving immediate and very short answers in a simple and accessible way especially for users who are not so familiar with digital content or for those who use screen readers and similar technology. Such information is certainly available on the web, but reaching it may not be easy for everyone. The proposed assistive chatbot technology is designed to make a contribution in this direction. The prototype has been specialized for Pisa hospital contents. A preliminary pilot test with ten users showed the feasibility of the proposed approach.

CCS CONCEPTS

• **Human-centred computing** → Accessibility; Empirical studies in accessibility.

KEYWORDS

Assistive Technology, eHealth Chatbot, ChatGPT, Accessibility

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1 INTRODUCTION

Recent advances in artificial intelligence (AI) put the focus on the potential of generative AI (e.g. ChatGPT) in many fields, including healthcare context. Generative AI can thus help provide answers to users who always have numerous queries and information search needs. When approaching a new hospital, for example, users need basic and advanced information. Getting information in advance may be very important for those users who have little time or limited digital skills for searching them on the web, or for people experiencing difficulties in localizing a target in large, complex and/or unfamiliar environments. People with visual impairment and especially blind people have mobility problems and need accessible information when exploring new places [9]. Analogously people with dyslexia can experience disorientation when exploring new places and have difficulty in decoding traveling information [8].

Generative AI can be defined as artificial intelligence focused on creating models with the ability to produce original content, such as images, music, or text. Generative AI can be exploited, for instance, for advanced chatbots. Chatbots can make it easier for users to search for information through more direct and natural interaction. Chatbots in healthcare can be devoted to patients or their caregivers, depending on the goals of the application. Healthcare chatbots aim to eliminate hospital wait times, schedule appointments, and provide assistance to users such as consultations or even diagnosis and psychological support. In this way, these agents reduce medical and organizational burdens while reducing costs.

Although it is useful to use chatbots in health care, they are complex to build, and poor design can lead to problems with accuracy in responses or, even worse, diagnosis.

An immediate and simple interaction for people who are not particularly familiar with technology, or for screen readers users, is included in the contribution of this work. Accessibility is crucial for enabling any user to benefit from any technology, including healthcare chatbots. For this reason, it is important to have accessibility in mind since the first phases of the chatbot design. As a result, two design aspects should be considered: (1) providing a simple user interface (or enabling a vocal interaction) and (2) delivering short and accurate answers in order to reduce the reading (leveraging the cognitive load).

In this paper, we present a simple accessible chatbot-based assistive technology – named ELSA - specialized for delivering information on the Cisanello Hospital located in Pisa, Italy. The proposed chatbot does not provide any clinical information and it is designed to support the user in visiting the hospital. It represents an interactive man-machine user interface, IMMUI, which has the main aim of simplifying user interaction and providing a more satisfying experience. We especially focused the answers provided by the

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assistive technology in order to give short and immediate feedback, as if the user were interacting with an operator.

A preliminary pilot evaluation with 10 users suggests a good appreciation for ELSA chatbot prototype. A further study is necessary to evaluate the accessibility of ELSA for blind and visually impaired users who interact via screen reader and voice synthesizer, since they were not included in the initial pilot test.

2 RELATED WORK

Recently an explosion of natural language processing (NLP) models in the machine learning field has started with the most popular introduction of OpenAI's GPT3 and 4. Research focuses on an exponential trend in ChatGPT potential, in every life sector, including healthcare.

ChatGPT ability to learn from discussions (or text parsing) enables it to learn and then deliver more accurate answers to future questions, making it more effective over time [1]. Chow et al. [3] suggest that ChatGPT could advance and overcome current specialized medical chatbots. The latest generation of NLP models are based on transformer models which are able to differentially weight the significance of each part of the input data [3]. These models trained on huge amounts of text data generate large language models (LLM) showing advanced abilities beyond extraction or summarization tasks, but also natural language generation. Therefore, they can be exploited as effective conversational AI or chatbots in healthcare.

A number of very recent studies are revealing the undiscovered potential of chatbot and ChatGPT in healthcare in many areas including training, diagnosis support, information delivery, patient care and research support [2, 4, 7, 10, 13].

ChatGPT would provide a boost to digital health initiatives delivering valuable input to clinical staff in healthcare centers located in remote areas [4]. The full potential of training can be discovered by integrated learning platform solutions driven by ChatGPT exploiting text-based information to offer customized learning experiences [7]. ChatGPT could support healthcare training by shortening the learning cycle time for students [4].

Chakraborty et al. [2] conducted a literature survey to discover and analyze relevant studies on Chatbots and ChatGPT in medicine. Clinicians exploited ChatGPT for various purposes: research, diagnosis, patient monitoring, for diagnosis support, and for learning about health literacy. ChatGPT can also be exploited as a digital therapist, in a mobile app for mental health or direct interactions [5]. ChatGPT is advancing hospital workflows by enhancing the precision and efficiency of tasks. It can perform administrative duties, including appointment scheduling and billing creation, which leverages the burden of healthcare clinicians who can have more time for patient care. This can improve the quality of patient care, increase efficiency, and lower costs [13].

While ChatGPT showed great potential in healthcare, concerns about its accuracy, reliability, medico-legal implications and privacy are still present [2, 4, 7, 10, 11, 13]. Exploiting ChatGPT in the healthcare sector may raise moral and legal concerns, including the need for transparency in AI-generated output and potential copyright breaches [2].

Appropriately trained with different sets of medical data, ChatGPT and AI models can acquire a more deep and comprehensive understanding of human health enabling more precise and personalized preventive, diagnostic, and therapeutic methods and strategies [12].

Despite all this exponential research, little attention has been devoted to the accessibility of ChatGPT and chatbot in general [6]. In this paper, we describe the design and implementation of ELSA, a specialized healthcare chatbot based on ChatGPT, designed following accessibility principles, in order to deliver a satisfying user experience also for screen reader users.

3 METHOD

Chatbot was chosen as an exploitable AI-based technology for an aid for those people who may find it more difficult to reach their way around the numerous resources, web pages and devices. Large amounts of content and complex layouts with a lot of items may be disorienting for people with special needs. Thus, a chatbot-based assistive technology is proposed to retrieve information on the web and deliver it in a simplified way to the user.

In this study, we applied a participative design approach for gathering user requirements and design the chatbot. A focus group was specifically arranged by the authors via a video conferencing tool. One of the authors is totally blind since her childhood and is very expert and proficient in digital accessibility. Other two visually impaired users participated in the design meetings, one aged more than 65 years. Another of the authors is dyslexic (and aged more than sixty). The focus group helped to define the main areas to consider when exploring a clinical environment, such as a hospital. After collecting the requirements, the design phase started.

The chatbot-based assistive technology was designed to allow (1) the user to ask specific and short questions such as "Where is the dermatology outpatient clinic located?", and (2) receive precise, targeted and brief answers, such as "The clinic is located in hall number 29".

The proposed chatbot system is designed as an assistive technology that retrieves information and processes it to display it in a way that is usable even for users who are less experienced or unfamiliar with the technology and devices. In the design and development of the system, Chat GPT and Google Maps were used to retrieve the information. Subsequently, the chatbot processes the obtained content to formulate targeted and short answers to be given to the user via a very simple user interface. In this very first version of the prototype, the user interface was not particularly considered, as the study focused more on the processing and management of (targeted and concise) responses. At a later stage, more attention will be paid to the design of the user interface.

A preliminary pilot test has been performed in order to verify the prototype pleasantness and acceptance and to understand if any change or improvement was necessary about graphic user interface and the delivered content. The test involved a comparison between the chatbot prototype and GPT chat to assess the difference between the responses obtained and the level of user acceptance/preference.

A Think-aloud protocol has been performed with a group of users recruited through one of the authors personal contacts. The participants were invited one by one to the lab. Then researcher

illustrated the aim of the assistive technology and showed how it works. Users were asked to ask simple questions to both Chat GPT and the chatbot prototype. In order to reduce the learning bias, 5 users interacted at first with ChatGPT and after with the chatbot prototype, and 5 participants vice versa. The researcher observed the interaction by annotating the main participant's comments.

4 THE CHATBOT-BASED ASSISTIVE TECHNOLOGY

In this section, the project, the design phase and the prototype are introduced. In this work, we limited to the design of the chatbot system for retrieving and manipulating information in order to present it in a short and direct manner to the user. Therefore, the system interface designed for the prototype is minimal and will be the subject of a more in-depth study in later stages. However, although simple, the principles of accessibility were considered while it was being developed.

4.1 Project Overview

Our project is focused on the development of an AI chatbot for Cisanello Hospital in Pisa, Italy. This tool is designed to provide accessible and user-friendly assistance to a number of users: inexperienced (i.e. not skilled users, such as aged persons), blind and visually impaired users who are constrained to interact via screen reader or magnifier. Due to its minimalist user interface and short answers, it could also benefit people with dyslexia and people with mild cognitive impairment, offering a simple interaction.

The primary objective of this project is to create a specialized chatbot-based Assistive Technology to offer information, support, and direction about Cisanello Hospital. By offering a user-centric solution, we hope to improve the hospital experience for people who are not familiar with this environment and in particular for visually impaired users, users with orientation difficulties and elderly people.

AI chatbots are nowadays essential resources that assist users with a range of tasks. However, because they are not designed for any user groups, in particular for individuals with little technical experience, their usability may be constrained. Grassini et al. [6] offers a systematic review of chatbots in the healthcare. The project includes the design, development, and deployment of the chatbot, which has the ability to direct users through medical information, respond to user queries, and help with navigation.

To define the main objectives for our AI chatbot, we considered the structural reference to Cisanello Hospital and explored available services that it could provide. In short, chatbot-based assistive technology is aimed at:

Answering basic questions related to the hospital and clinical environment.

Providing information on how to reach and contact the hospital.

Offering insights into the hospital's layout, including buildings and departments, and distinguishing between entrances.

Assisting the user orientation within the hospital by delivering information useful to reach the target building/entrance (information, maps).

Before proceeding with the design of the type of interaction, we formulated some questions that we would like to ask when going to a hospital (e.g. for a visit) to both ChatGPT and Google. The design was guided by the hypothesis of simulating the behavior a person might have when calling someone on the phone to get information before going to the hospital, such as "Where is the eye clinic?", or "How do I get to Building E?", etc.. As mentioned before, the participative design has driven the whole creation of ELSA including visually impaired people. To express different interaction queries, the questions were selected by the design team.

By analyzing the answers obtained by systems like ChatGPT and Google, we tried to understand whether the type of answer provided would be adequate to provide the necessary and brief information to the user unfamiliar with the technology, and its needs. When developing the chatbot prototype, ChatGPT and Google APIs have been exploited to carry out searches along with content scraping, parsing, processing and combining results to deliver a shorter and more focused response.

In the design phase, we planned to (1) retrieve information from the web pages on the official site, and (2) adapt the information retrieved to a more compact and precise format.

4.2 Requirements and Design Specifications

Selecting the right target audience for our chatbot is a fundamental decision that underpins the success of our project. The design phase of our project is anchored by identifying the target audience. In this context, the project is carefully tailored to two specific user groups: technical unskilled users and people with visual impairments. These groups include individuals for whom technology is new or not confident, who are in healthcare settings, or who require special assistance due to a visual impairment or inexperience in using ICT resources. Based on these considerations, some specifications for the system were formulated.

Accessibility was an important aspect of our project. To ensure that our chatbot could be used by screen reader users and provide differentiated input and output, we carefully selected our technology stack. We ran tests and identified challenges with different libraries. A comprehensive understanding of the needs of the target audience is the foundation for our design objectives. These objectives cover a broad spectrum of use cases, each carefully crafted to address the unique requirements of our users:

Information accessibility: One of the key objectives is to make critical hospital-related information simple to find. This provides information on the hospital's services, offerings, contacts, and location.

Facilitating communication: communication is made easier thanks to the chatbot, which acts as a medium for consumers to ask requests and receive quick, precise responses. For those who require instant assistance or information, this is crucial.

Navigational aid: we go out of our way to direct visitors through the hospital's layout. This is crucial for blind individuals who require detailed instructions within the facility.

Orientation support: The chatbot helps users locate the hospital areas (e.g. easily find information on specific departments, facilities, or rooms).

A focus group for eliciting user requirements and to collect queries related to the clinical environment was carried out using a

videoconferencing system. The main issues that emerged from the focus group are arranged as follows:
a) Navigating the Hospital Website:
Complex layouts and pages are difficult to navigate
Information is not easily visible and reachable (may be nested in web pages)
Information are not logically arranged
b) Interacting with a chatbot or AI-based tool (i.e. Chat GPT)
Input requires many steps via keyboard. The screen reader user repeatedly needs to switch between the input box and the answers that come out
Output is verbose. The content may be difficult to understand due to its length and complexity. People using screen reader and voice synthesizer have a sequential reading which takes time. So it is important to keep content short to not overcome users with not useful content.
Output is unstructured. Structure can help blind people to have an overview and jump immediately on the relevant content. Furthermore, too much unstructured text may require more attention when reading by the user both visually and auditorily
Starting from these observations and comments, the team considered the following specifications when designing the chatbot prototype:
Simple Interface: minimal and with a very simple layout
Concise, not verbose Output: the information received by submitting queries to services like ChatGPT and Google are opportunely managed and simplified in order to provide an immediate answer
Multimodal interaction input: textual or vocal to allow the user to use the preferred natural interaction
Contextual queries: Focusing on topic (i.e. discarding queries out of context)

4.3 The Prototype

In order to test how to offer short and concise answers to precise questions, a very initial prototype chatbot called ELSA was developed. As mentioned, ELSA was designed to give the user precise information on certain areas of the Cisanello hospital. The information to be used to formulate the answers was obtained from GPT Chats and Google services. The received answers were processed to be concise and non-verbose, while providing the required information. ELSA's very initial interface is accessible and basic in terms of user possibilities. The ELSA chatbot interface is REST-based (Representational State Transfer). The REST architecture splits the system into a client (which makes requests) and a server (which provides responses). This separation allows for better scalability and simplifies the management of the system components.

The interface of the prototype is very minimal, because the development focused mainly on the part of searching, retrieving and structuring information to provide targeted and short answers. The user interface of ELSA adheres to a minimalist and highly intuitive design. Figure 1 shows the web app's main page, designed for easy comprehension, including via screen reader.

When loading the page, ELSA welcomes users. The user can input the question in the text box or can dictate the query by voice. By clicking the "Send" button, after verifying the appropriateness of the question to the clinical context, the request triggers the

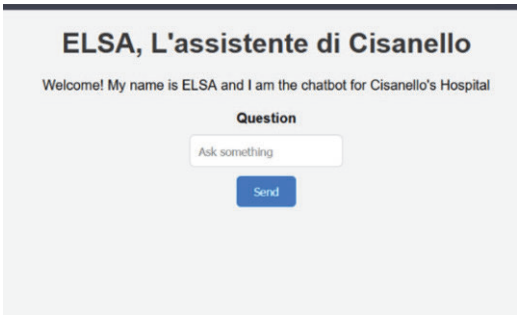

Figure 1: ELSA home page

Figure 2: ELSA answer

ChatGPT and Google queries and processes, combines and refines the received outputs, delivering a focused short answer to the user. Otherwise, the system prompts the user to rephrase the query. Figure 2 shows an example of the system answer.

The user is looking for Dermatology Clinic in Pisa. ChatGPT is focused but the answer is more conventional and verbose vs ELSA which only provides an essential answer, as shown in Table 1.

Our design approach blends technology and empathy, ensuring that our chatbot caters to both inexperienced and screen reader users. It employs a RESTful interface and features a user-friendly design that promotes clear communication and accessibility.
To make the answer reading immediate even via screen reader, a 'live ARIA region' has been applied receiving programmatically the focus when new items are generated. In addition, some refinements to the interface code were used to allow quick navigating question by question (<h1> levels), and so to answers (arrow keys) to improve keyboard interaction via screen reader.

4.4 Development Environment

The AI chatbot prototype was developed using the Python programming language. It serves as a web application created with Flask, capable of answering user queries by searching Google or generating responses based on OpenAI's language models. To be considered accessible, it needed to be usable with screen readers and offer differentiated input and/or output modes. To achieve this, it was necessary to use coding libraries that could integrate these technologies. After conducting some tests, Flask and OpenAI libraries

Table 1: Example of answer: ELSA vs ChatGPT

System	Answer
ELSA	Building 11 – 2^{o} floor. Info: Director or Responsible: Prof. Marco Romanelli.
ChatGPT	Here is information about the Pisa Hospital Dermatology Clinic: Name: Dermatology Clinic Hospital: Azienda Ospedaliero-Universitaria Pisana (AOUP) Address: Via Roma, 67, 56126 Pisa PI, Italy Phone: +39 050 992111 You can contact the clinic directly through the phone number provided for additional information or to book a dermatology consultation.

have been selected to develop ELSA. They are highly compatible with each other and open to concepts of accessibility, making them suitable choices for our project. Specifically, the following libraries have been used in the development:

- Flask: A micro-framework for web development in Python, designed to simplify the creation of lightweight and scalable web applications.
- OpenAI: Providing functions and methods for sending requests to OpenAI's language model API and receiving responses.
- python-dotenv: A Python library that streamlines the management of environment variables within an application.
- pyttsx3: Used for text-to-speech synthesis, which converts text into natural language audio output.
- requests: Employed for sending HTTP requests to retrieve content from web pages.
- Google search: Utilized for conducting searches on Google.
- lxml: Used for parsing HTML content of web pages using XPath expressions.

5 PILOT EVALUATION

A preliminary evaluation was performed with 10 participants, 5 male and 5 female. Participants, aged between 18 to 25 years were recruited by one of this paper's authors. All users are students of the Pisa University. This preliminary evaluation aims to evaluate the pleasantness of the UI and assess user satisfaction with the answers provided by the assistive technology compared with those generated by ChatGPT. The young population has been targeted since they are expert technology consumers, and could provide valuable feedback. Although the user group involved in the pilot test did not include either aged persons or screen reader users, the first evaluation approach was to analyze whether there was an appreciation of the answers provided even by those who may have a good level of technological skills. The next step will be to extend the test to the target user categories. In fact, in the first step we focused on the quality and pleasantness of the answer content, independently from the age and technology skills. The user interface assessment via screen reader will be performed in the following study.

Users were asked to formulate simple, targeted questions regarding the environment of the Cisanello hospital. More specifically, tasks included the formulation of five questions concerning the hospital of Pisa to be submitted to both Chat GPT and ELSA chatbot. Next, the user had to perform the comparisons of answers provided directly by ChatGPT and ELSA. The five questions for evaluating the different feedback were:

- How I can reach the Hospital in Pisa?
- Where is the Dermatology Clinic?
- How I can schedule a visit in the Cardiology Clinic?
- The Dermatology Clinic Director performs private visits?
- What is the visit time in the cardiology Clinic?

Eight out 10 users (80% of participants) found the ELSA answers more understandable and direct (short and focused), compared to those generated by OpenAI, which were often considered too long and dispersive. Two participants were neutral in the evaluation declaring that verbosity of ChatGPT is not invasive since they can jump to the next paragraph rapidly. Actually, ELSA makes ChatGPT answers shorter, focusing on concise and effective phrases. Visual interaction enables one to immediately scan and skip parts of text and jump on relevant content while the screen reader interaction, being vocal, is intrinsically sequential (if information is not appropriately structured to easily navigate and skip content).

Furthermore, all participants considered ELSA's ability to survey the various departments in the hospital useful, indicating their floor, contact information, and the person in charge. This feature is very useful not only for people approaching the hospital first time but also for people living in the area since such a large hospital makes it difficult to orient, often users need guidance for reaching a specific area, studio or lab. These preliminary results encourage the deepening of the usage of chatbot-based assistive technologies.

6 CONCLUSIONS

Nowadays, generative AI is showing great potential in the healthcare field. However, this technology is still in the beginning and may not yet be for everyone, mainly because of its interface and way of presenting dialogues and responses. In fact, despite the number of bots and apps, literature shows that accessibility is neglected and an easy and satisfying interaction is not guaranteed for anyone, regardless of their abilities. This hampers human rights and increases the digital gap.

Exploiting ChatGPT model and Google service, we have developed a very first prototype of a chatbot-based assistive technology, to get information on a target Hospital, in a simple and effective way (i.e. Responses short and direct). The proposed chatbot provides a simple and inclusive experience for interaction and discovery of hospital information. Thus, the retrieved information was manipulated to provide less verbose and complex answers. Furthermore, the design with ARIA suite and some cares in the interface code

enables an easy and rapid detect the answers when interacting via screen reader. A preliminary evaluation with ten sighted and young users revealed a very positive response for the proposed assistive technology, which is less verbose than ChatGPT. Future work will focus on the user experience for screen reader users and elderly.
To conclude, although still very preliminary, the study is an example of how generative AI alone is not yet sufficient to provide usable and practical answers for all users. Assistive technology tools and accessible, usable interfaces may once again represent valid ICT solutions in an increasingly inclusive society.

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