# Chatbots as a User Interface for Assistive Technology in the Workplace

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**Abstract.** Chatbots are a well-established technology. Early developments date back to the 1960ies. In recent years the concept is discussed broadly again and new fields of application, especially in the workplace, have been identified. Reasons for this renaissance are the widespread diffusion of mobile devices (e.g., smartphones, tablet computers) in both home use and use in the workplace. Within the field of assistive technology, chatbots are a rather new phenomenon. In our research we investigate the usage of a chatbot as a conversational user interface. We focus on the workplace setting of professional caregivers. In addition, we discuss implications for persons with increased need for care and other stakeholders (e.g., family members). We present a prototype that is fully administered and operated by communication via a messenger service. This messenger service is connected to a chatbot. In this paper we assess the impact of the chatbot on the system's perceived ease of use. In addition, we discuss potential benefits and possible risks of the chatbot technology for caregivers, persons in need of care and family members. We conclude that the chatbot technology is a viable technology for certain types of ambient assistive technology. However, it comes with some limitations and it is not suitable for all target groups. Further research might investigate possible useful combinations with other interaction technologies (e.g., speech recognition, gesture control, etc.)

## 1. Introduction

Chatbots are a class of conversational software agents. These agents possess some kind of intelligence or at least a set of algorithms that allows interaction between humans and computer systems using natural language. In some cases they are designed to have an ongoing conversation. In other cases they may be commanded to execute tasks. Therefore the use of chatbots in workplace environments is increasingly being investigated.

While the concept of software-based chatbot agents is well-established, not much is known about the effective and efficient use of chatbots in the workplace. In recent years, the vast diffusion of mobile devices like smartphones and tablet computers has fueled new discussions on useful applications of chatbots in working environments also within the domain of ambulatory medicine (Abashev *et al.*, 2017). In this paper, we present a prototype of an instance of assistive technology that aims to support the care of persons with increased need of care (PINC; e.g., elderly people or patients with mild cognitive impairments or early forms of dementia). This assistive technology, which we call iCareBot, is based on a Raspberry Pi single board computer and is equipped with a camera that is used to monitor a specified area in the residence of the PINC (Judt *et al.*, 2017). The monitoring consists of the detection of activities during rest periods (e.g., at night) and the detection of unusual inactivities during the day. The user interface of the system is based on a chatbot. The chatbot is used by multiple user groups, i.e., the professional caregiver, family members and last but not least the

PINC oneself. The chatbot which is contacted via a messenger service is used both to administer the system and to operate the system. Communication can be initiated by the chatbot (i.e., in case of an alert) as well as by the various users (e.g., in case of a request or an administrative activity).

The solution that we present was developed under the guiding principle that ambient assistive technology should be designed in a way that also non-professionals can operate and install it. However, in this paper we discuss implications of the chatbot as a user interface for various stakeholders, and in particular the professional caregiver. Here we argue that chatbots offer new ways to increase system's perceived ease of use for each of its user groups. We focus on the discussion of potential benefits and possible risks of the chatbot technology for caregivers, persons in need of care and family members. The technology of a chatbot as a conversational user interface

The remainder of this paper is organized as follows: First, we present related literature on chatbots in general and on their use in the workplace. Second, we present the proposed prototype of the iCareBot including potential use cases, system architecture and we lay out how chatbots can be used as a conversational user interface. Finally, we conclude with an assessment of the use of chatbots in the workplace and we identify avenues for future research.

## 2. Related Literature

According to Abu Shawar and Atwell (2007) a chatbot system can be defined as a software program that interacts with users using natural language. The language might be written text or spoken language. Today chatbots are not a new technology. Early developments date back to the 1960ies, for example when Weizenbaum (1966) presented the chatbot "ELIZA" that resembled a person-centered psychotherapist. This system answered questions of a person based on pattern matching and enabled a very simple conversation. During the 1980ies chatbots were developed by the computer gaming industry. While some demonstrations of functional chatbots aimed at fooling people to believe the chatbot is a human-being, most developments seek to provide valuable use cases in domains such as information retrieval (Abu Shawar and Atwell, 2004), education (Kerly *et al.*, 2007) or customer service (Accenture Digital, 2016; Simonite, 2017).

Depending on the application domain, where a robot that interacts with people is used, the user interface is of great importance. User interfaces have to be intuitive, in a way that untrained and non-technical users can easily operate the system without instructions (Burgard *et al.*, 1998). There are several field reports on chatbots as a user interface for robots. For handling natural language input, most implementations use a pattern-matching rather than sophisticated grammatical parsers (Gockley *et al.*, 2005; Wallace, 2009; Carpenter, 1997-2011). In particular, for conversational chatbots there is a solid base of research and there are also recommendations for the development of "good" chatbots available (e.g., Vetter (2002), Radziwill and Benton (2017)).

Within the field of assistive technology, however, chatbots are a rather new phenomenon. Bigham *et al.* (2008) investigate possibilities to inspire blind high school students to pursue computer science with instant messaging chatbots. Tokunaga *et al.* (2016) develop a personalized and context-aware reminder service for people with dementia using a chatbot. Atay *et al.* (2016) develop and evaluate a chatbot within a smartphone app that engages with members of an older community. Because involvement in conversations may help dementia patients, the chatbot fosters interaction with elderly people by triggering conversations on various pre-defined topics.

Consecutively, Tokunaga *et al.* (2017) design and develop a virtual agent for elderly care which provides personalization. This virtual agent is an animated, human-like graphical chatbot robot that supports simple cares such as greetings and reminder schedules. Since each elderly individual has different needs for care, personalization is an important aspect. However, personalization increases development cost. Tokunaga *et al.* (2017) find that adapting the care robot to individual lifestyles is challenging. Furthermore, deploying such a care robot in a regular home is quite expensive.

The usage of messenger-based chatbot systems as a communication device for the purposes of translational medicine is identified as a means to reduce costs and time on routine operations (Abashev *et al.*, 2017). Within the domain of mobile health Abashev *et al.* (2017) present a chatbot model that supports translational medicine in the following processes: (1) surveying patient’s health condition, (2) personal reminders/alerts, (3) chat with the doctor/consultant, (4) appointments for consultation/medical procedures, (5) m-health data collection from apps and customization, and (6) the chatbot system can transmit the results of prognostic models to the patient on request, taking into account the parameters of their behavioral patterns (nutrition, physical activity, etc.), for them to adjust their behavior to the preset target indicators. Tcarenko *et al.* (2017) use the messenger service Telegram to communicate with an Internet-of-things enabled fall detection system, that senses falls of elderly persons using a motion sensor in a wearable device. In case of a fall event a notification is sent via Telegram messenger.

## 3. CamBot – Presentation of a Prototype

During the research program iCare (Bächle *et al.*, 2016) an architecture has been developed, that can be used as a foundation for several different applications (Judt *et al.*, 2017). One of them is the CamBot (see fig. 1) – a system to monitor a home environment of PINCs to detect dangerous situations. Another system – ScanBot – is used for presence control in a nursery home or private residences. In this paper, we present the CamBot as an example for an assistive technology that is operated and administered through a chatbot component.

### 3.1 Use Cases of CamBot

Dementia patients in early stages of their disease develop a tendency to walk around. Also, they lose their sense of time. It is quite common that such persons wander around within their own dwelling for longer periods. This might even happen at night-time. This is problematic for several reasons: (1) The concerned person lacks regular sleep. (2) Due to fatigue, exhaustion and darkness at night the risk of injury is elevated. (3) In case of an emergency potential helpers might notice the problem not immediately.

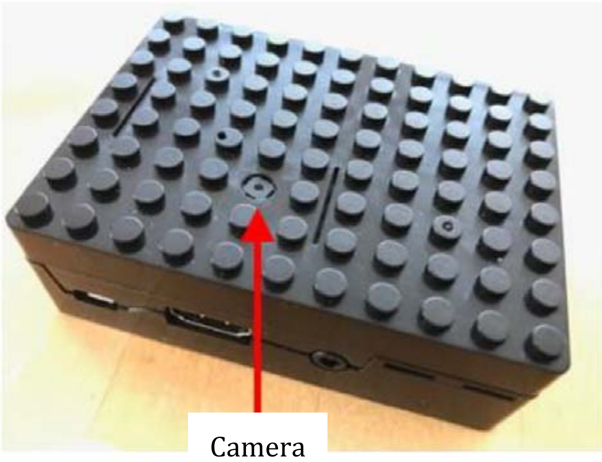


Fig. 1: CamBot with built-in camera

The CamBot can be set up to monitor a specific area within an apartment of a PINC using the built-in camera. A software-based motion detector that operates with image recognition is able to notice movements of a person in the controlled area. In the settings of the CamBot there is a distinction between times when personal activity is rather unusual (e.g., during the night) and times when is to be expected (e.g., during the day).

Various use cases arise from that: Continued activity during off-time can trigger an alert to a professional caregiver or a family member. Several severity classes can be defined (e.g., depending on the time of day or length of the activity). The chatbot component of the CamBot triggers an alert which is transmitted through a messenger service directly to the smartphone of the receiving party.

Another use case stems from the opposite case, when there is no activity over a longer period of time during allowed time (e.g., during daytime). Again, several severity classes are possible. When a PINC usually gets up at 8:00 in the morning, no activity until 9:00 might not be too worrisome. However, no movement in the apartment until midday (or even over several days) could be alarming. Depending on the severity class of the event, different stakeholders can be informed or alarmed (professional caregivers, family members or even emergency medical services).

Professional caregivers can be informed based on severity classes of events that take place. The technology of the CamBot can be used to restructure the work routines of professional caregivers both by providing event-based information and by involving other stakeholders like family members in non-critical care demands.

Furthermore, the supply of care can be expanded and higher levels of quality can be achieved. In particular, in early stages of dementia ongoing professional care is typically not deployed when PINCs are still living independently and self-contained within their regular living environment. Therefore, care can easily be phased in on an on-demand basis.

### 3.2 Architecture


Fig. 2: Components of the CamBot

The CamBot consists of a simple single board computer with an integrated camera (see fig. 2). We use a Raspberry Pi 3 Model B. For the initial installation a monitor, keyboard and mouse are needed. After the operating system and the CamBot software have been installed and the CamBot has been connected to the internet (e.g., through WiFi) all further administration can be done using a smartphone and the messenger service “Telegram”.

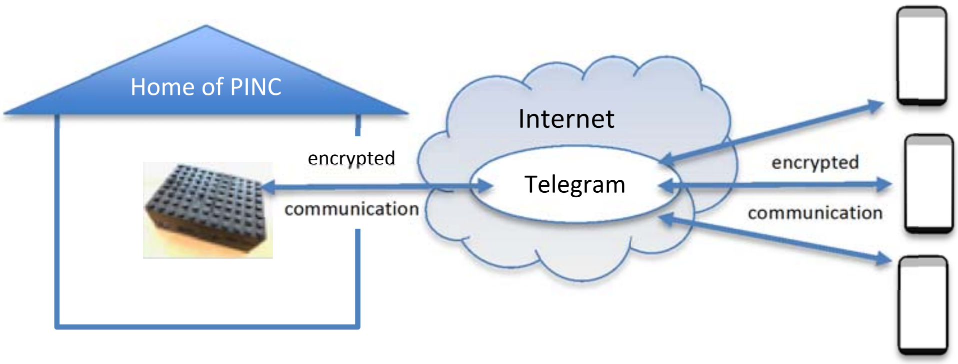


Fig. 3: Communication of CamBot with caregivers through messenger service

The messenger service Telegram was chosen as it offers good support regarding bot technology and it provides a well-documented API. The communication over the internet between all parties is encrypted (see fig. 3). This applies to both the information exchange from the CamBot to the Telegram messenger service and the information exchange to the smartphones of the users. Communication partners can easily be added or removed from to the network (e.g., when a new professional caregiver joins). Notifications can be customized in a way that professional caregivers only get critical notifications whereas close family members might get more regular status updates.

The integrated chatbot consists of various components (see fig. 4). In our case the catalog service contains all commands that are needed to administer and to operate the system. The question answer service could be used to implement features that allow conversation like "when was the last activity in the kitchen?" The bot actor is used to send out alarm messages in case of an event. It also processes commands (e.g., "send picture of living room").

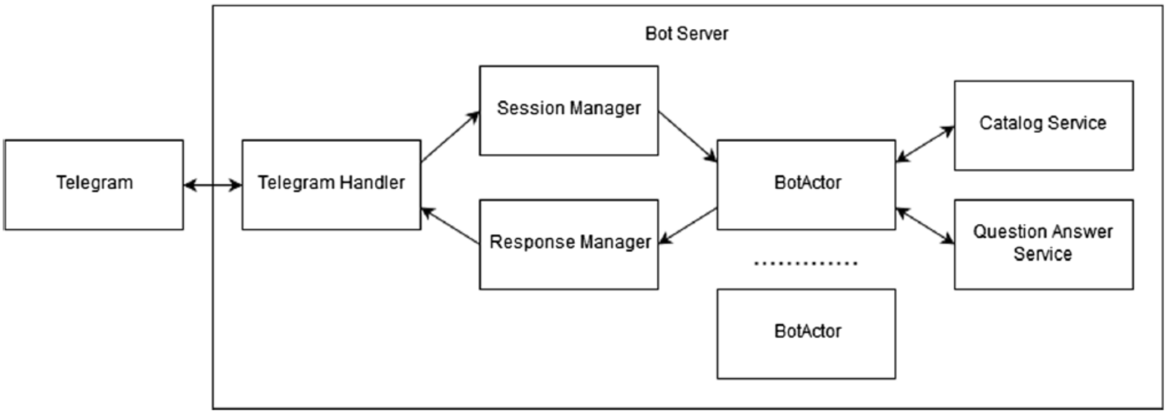


Fig. 4: Pattern of a chatbot system using Telegram (Abashev *et al.*, 2017)

### 3.3 Chatbot Interaction

Chatbots are a suitable means to reduce barriers in human computer interaction. The use of natural language makes computers easily accessible by non-technical users and therefore reduces the need for special instructions or trainings. For end users there is no need to learn special "programming languages" or specific keywords to be able to communicate with the system and to request services.

Klopfenstein *et al.* (2017) identify the following advantages for the users of chatbots amongst others:

(1) Instant availability: At least on the end user side, there is no complex installation or configuration necessary. When using the chatbot via a messenger service on a smartphone, it is only required to download the app. To do so no technical expertise is required.

(2) Gentle learning curve: As most smartphone users are familiar with texting, it is easy to begin to use a chatbot system. Usually the basic features can be used intuitively.

(3) Notifications: Although that too many push notifications on a smartphone might be perceived as annoying, the communication through messenger service is daily routine for most smartphone users.

(4) Social graph and contacts: Users are already accustomed to voluntarily sharing contact information in messaging apps. Group information can be used to share information within the users' familiar networks (e.g., family or professional care organization).

(5) Platform independence: Chatbots, that are accessed through messenger services like Telegram, provide platform independence because messenger apps of widespread messengers are available for most mobile operating systems (e.g., iOS, Android, etc.)

(6) Authentication: As the user concept of the hosting platform can be used no registration with username and password is necessary. This is a known obstacle to user onboarding.

(7) Asynchronicity: Exchanging instant messages is an asynchronous task: after sending a message, users do not have to wait for a reply. When the receiver of a message is temporarily not available the message will be delivered later.

Communication changes when people communicate with an intelligent agent as opposed to with another human. Hill *et al.* (2015) find that people communicate with chatbots for longer durations (but with shorter messages) than they would with another human. Additionally, human–chatbot communication lacks much of the richness of vocabulary found in conversations among people and exhibits greater profanity. These results suggest that there are notable differences in the content and quality of such conversations. The replacement of social interactions and human conversations by chatbot activities might therefore result in a loss of quality. However, when the aim of the chatbot is to control an assistive technology this should not be an issue.

As in our case the chatbot is used by various user groups the type of conversation might be adaptable. While PINCs may prefer more natural language type communication, professional caregivers might prefer shorter commands and rather keyword-based communication to achieve a more efficient communication. The systems' perceived ease of use is assessed differently depending on the various user groups. The requirements of PINCs vary from those of professional caregivers that use the system as part of their working routine.

### 3.4 Limitations of the Technology

Our proposed prototype CamBot comes with various limitations. These limitations apply to both the CamBot in general and the chatbot as its user interface. General limitations are: As we use consumer grade components that are integrated by the end user, we do neither achieve high availability requirements nor medical device specifications. Instead we aim to provide a solution that offers a low-threshold service. The image recognition component of the CamBot is a central module of the solution. Initial tests indicate correct functioning of the system. Future research is planned to evaluate accuracy and precision.

Apart from technical aspects, the ethical dilemma between privacy and safety needs to be solved individually by each PINC. Surveillance in all rooms might achieve highest possible safety for the PINC. However, some PINCs might be hesitant so equip private rooms such as bathrooms or bedrooms with camera equipment, in particular when external persons (e.g., professional caregivers) have access to image material.

Furthermore, there are some specific limitations of the chatbot: As the chatbot is contacted through a messenger service (in this case Telegram), the functioning of the system relies on the operation of this commercial service. In case of downtimes or changes in the service policies (e.g., lower service levels for non-paying users or for API-users), there is an immediate impact on the performance or availability of the chatbot.

So far the chatbot of our prototype processes commands that are based on several keywords. Some of them resemble English language words. This could pose a language barrier for all types of end users: PINCs, family members and professional caregivers. For the future, multi-language support is an issue for further developments. As discussed above, the optimal level of natural language versus short and efficient commands based on keyword needs to be determined.

Finally, an issue might arise, when professional care coverage gets reduced because of such a new ambient assistive technology. We view the proposed solution rather as an additive assistive technology than a replacement of human care.

## 4. Conclusions

When reviewing the literature on assistive technology for independent living with dementia it becomes evident that a large portion of research focusses on the technical dimension of solutions as opposed to ethical questions or how the proposed solutions can be included in the comprehensive (social) care system (Bächle *et al.*, 2018). Chatbots, such as the proposed prototype, might help to integrate a technical solution in complex workplace settings.

The care system is characterized by various different roles and stakeholders. In particular, within the care of PINCs information sharing between the different stakeholdes such as professional caregivers, doctors, family members and the PINC oneself is important. The conversational user interface of a chatbot allows adaptability and personalization depending on the user group.

We conclude that the chatbot technology is a viable technology for certain types of ambient assistive technology. However, it comes with some limitations and it is not suitable for all target groups. Further research might investigate possible useful combinations with other interaction technologies (e.g., speech recognition, gesture control, etc.) In addition, research on differences in conversational requirements between PINCs and professional caregivers that use chatbots in the workplace is needed.

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