Remembranza Pills: Using Alexa to Remind the Daily Medicine Doses to Elderly

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Abstract. European countries are facing a population widespread ageing. The percentage of third age inhabitants is becoming higher, specially in rural areas, where older adults demand special services in order to improve their life, notably when they live alone. This way, some tasks like medicine management can be a very hard day-to-day challenge. In this paper, Remembranza Pills is introduced. This is a platform that supports elderly at daily medicine takes using Alexa. The system reminds users the medicines and pills that have to be taken in each moment of the day using a web platform to manage the prescriptions. In this manner, medical staff and relatives can keep control over consumed doses.

Keywords: Elder healthcare · Medicine disposal · Human computer interaction · Amazon echo · Alexa Skill

1 Introduction

Nowadays, European population is becoming elderly. Countries are experiencing a widespread ageing of population, involving the society into the challenge of providing appropriate services and support. Around 20% of the European population is over 65 years old what means that 1/5 of the inhabitants are elderly [1]. This reality gets intensified at rural areas, where more than 30% of the population is over 65 [2]. The elderly people needs are highly specific and demand measures that allow them to develop a successful day-to-day. One of the main tasks that elderly have to face is medicine takes.

In this project, a technological solution is provided with Remembranza Pills. The platform allows elderly to keep a control over medicine takes with an Alexa Skill. This way, when users ask for what medicine should be taken, Remembranza Pills will answer with the medicines that correspond to that time. Furthermore, the system enables medical staff and relatives to keep control over the taken pills.

The rest of this paper is organised as follows. Firstly, Sect. 2 describes the overview of the platform, explaining the full functioning and the role of each

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system component. Secondly, Sect. 3 specifies details about the implementation decisions, explaining the internal performance of the different elements. Then, Sect. 4 reviews related works about Voice Assistants and Elderly, including several project related to eHealth and medicines management. Finally, Sect. 5 draws some conclusions about the paper and exposes future outlines and research lines.

2 Overview

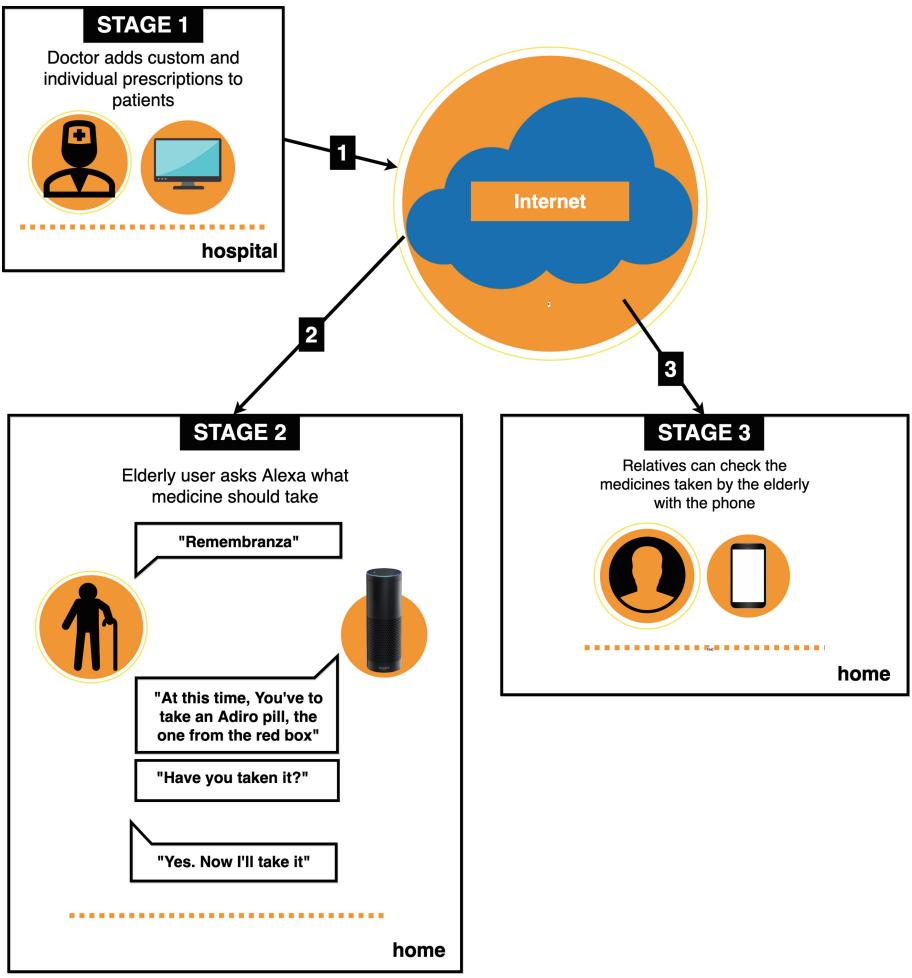

Fig. 1. Overview of Remembranza

Remembranza Pills is a platform that involves multiple services and functions. The main idea is providing elderly with a support at medicine takes, explaining

which pills correspond to each moment. Furthermore, Remembranza also checks, through a question, whether the elderly has already taken them. The elements involved in the schema are mainly two: a web platform that allows interaction with the medicines of the patient and an Alexa Skill that communicates with the elderly user. Also, an Android app is provided in order to let relatives know about the takes information. These components keep synchronised with internet connection.

On the one hand, the web platform is the main interaction point. It is a profile-based system that allows medical staff to manage the medicine doses of each patient while relatives can check out the progress. This way, Remembranza provides an online tool for doctors that keeps all medicine takes of each patient while supplies details about the times the elderly asks which pill should take and whether it has already been taken. It is important to take into account that most of elderly are not able to recognise or distinguish the pills and medicine names thus, in order to solve this challenge, the platform includes an individual and personal description that the doctor can specify for each patient. The web platform is a substantial component that brings relevant easily read information.

On the other hand, Alexa Skill is the key to complete the functioning of Remembranza. Using the information provided through the web platform, the elderly can check which medicines should take. Depending on the time of day the user asks, the skill will answer with the appropriate pills before asking if the user has taken the medicines. After this process, the skill updates the web platform information depending on the user's answer.

Taken the overview into account, the operation of the platform involves three main stages: (1) doctor specifies prescription, (2) Alexa reminds elderly the medicine that should take and (3) relatives check the historical doses information.

In order to allow medical staff to define individual and personal prescriptions, the web platform includes the patient set assigned to the doctor and defines the pertinent operations. These options involve the prescription definition with a time range, medicine identification, dose specification and a brief description that allows elderly to identify the medicine with a familiar representation, e.g "the red pill" or "the one from the blue box".

Once the system keeps the prescriptions specification, the elderly is able to ask Alexa Skill what medicines should take at anytime of the day. This way, saying the hotword "Remembranza", the device will answer with the corresponding medicine dose at that moment and it will ask whether the user is going to take it. In the case the elderly accepts, a new medicine take will be added to the system.

As these stages are completed, the platform stores all relevant information about the daily dose takes. Thus, relatives can check from the Android app if the elderly has been taking the medicines and monitor the progresses.

3 Architecture

This section introduces and describes the elements that compose Remembranza implementation. Concretely, the implemented components are the following: (1) the web platform used by the medical staff for the management of medicines and takes, (2) the Alexa Skill to interact with the elderly patient to help him remember to take medicine, (3) an Android app that enables relatives to review statistics about the use of the skill and finally, (4) a server that centralises all the information of the components, working transparently to the user.

(1) Web Platform is designed to provide medical staff with a friendly interface, for this reason MVVM [3] architectural pattern is used. It is essential to provide the user with an easy-to-use interface so the CRUD(Create, Read, Update and Delete) operations are able on prescriptions management. Concretely, the platform is developed using the Angular framework [4]. Also, the platform sends requests to the server through the Application Programming Interface (API) in order to manipulate the data hosted in it. When the data is hosted into server, Alexa skill can request each medicine prescribed by the doctor (Fig. 2).

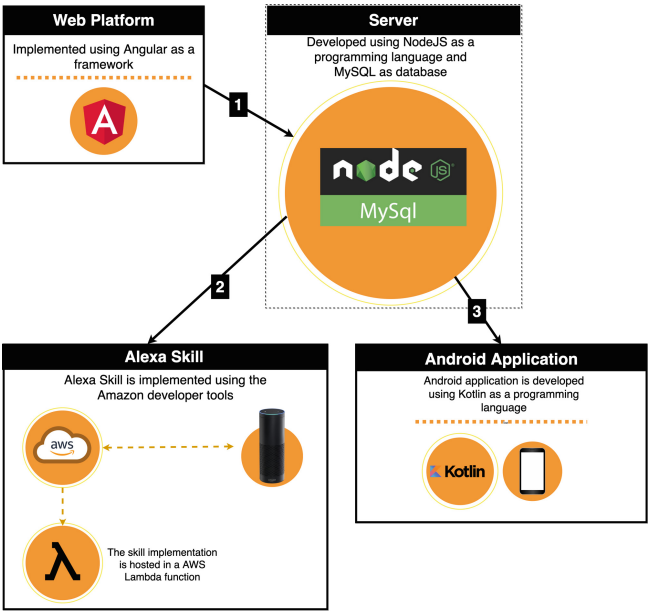

Fig. 2. Platform architecture.

(2) Alexa Skill is developed using the Amazon developer tools. The Skill is invoked with "Remembranza". In order to recognise the needs of the elderly, intents to interact with individuals are defined. These intents are triggered when

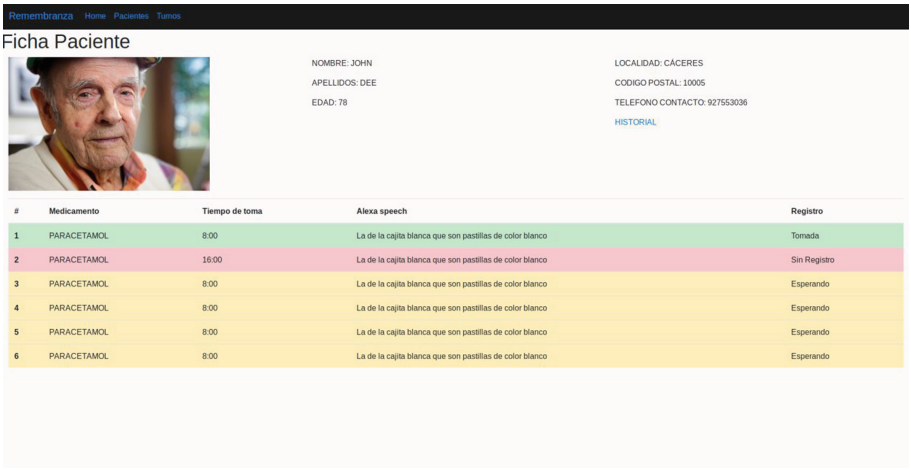

Fig. 3. Elder profile page in web platform.

the elderly makes an specific request to Alexa. Also, all the skill information is represented through a JSON (JavaScript Object Notation) format (Fig. 3).

On the other hand, the skill implementation is hosted in a AWS Lambda function. AWS Lambda is the Function-as-a-Service (FaaS) platform of AWS which is able to run code without server. AWS charges for service when the use limits are exceeded. The AWS Lambda connects with the server to receive and announce the medicine prescription that the elderly has to take at the time of the request. Concretely, the AWS Lambda is developed using NodeJS as programming language.

(3) Android Application represents all the information about the prescriptions of the elderly patient. In order to allow relatives to check elderly evolution, the application connects with the server to show the use statistic of Alexa skill. Relatives can consult reports with daily, weekly, monthly and annual filters. Reports contain information related with the elder interaction with the skill.

(4) Remote Server centralises all the information about the elderly patients and their medicine. The server allows clients to interact with stored resources through an API. Concretely, the server stores the data using a MySQL database. Also, the server provides an interface that enables stored management information in database. This interface is developed using NodeJS as programming language. The components previously defined perform requests over the API. This process is completely transparent to the user.

4 Related Works

The eHealth field is fulfilled by ideas that integrate technology in many daily tasks of elderly lives. Next, several related works are introduced and classified

into different topics: (1) Medicines remind, (2) Elderly assistant communication and (3) non-function properties management.

(1) Medicines remind is the topic that involves projects and devices that remind elderly the daily medicine takes. The most relevant works in this group are: Feasibility study of a robotic medication assistant for the elderly [5], Multimodal and adaptable medication assistant for the elderly: A prototype for interaction and usability in smartphones [6] and "It's time for your life": How should we remind patients to take medicines using short text messages? [7].

Feasibility study of a robotic medication assistant for the elderly [5] shows a solution to medicine management in elderly population. Through a touch screen installed in a robot, the system is able to remind elderly the pills and medicines that should take, following a dialog schema that checks whether the user has already taken them.

Multimodal and adaptable medication assistant for the elderly: A prototype for interaction and usability in smartphones [6] is a solution that uses smartphone technology to remind elderly the medication takes. The system provides the user with several information about the medicine including a custom response in case of forgetting medication. It also considers context situation in order to adapt output. This way, the application uses the camera of the device to detect the distance between the user and the screen and enlarge proportionally screen content. Furthermore, ambient noise is taken into account in order to establish notifications and speech volume.

"It's time for your life": How should we remind patients to take medicines using short text messages? [7] is another approach to medicine reminder, in this case oriented to HIV-positive patient. This research exposes a system based on SMS that uses a simple and concise speech that guarantees confidentiality and privacy.

These purposes define different solutions to remind medicine prescriptions. However, each one specifies alternative approaches. Remembranza Pills purposes an interaction model essentially based on voice. This way, users do not have to deal with further operations than talking.

(2) Elderly assistant communication is the second main topic found at literature. Voice assistants are a disruptive technology that has to face the challenge of being able to communicate with every possible user. Elderly requires some special points at conversation like concise speech and a successful management of times. Next, most relevant articles in this topic are shown: Design and development of Medication Assistant: older adults centred design to go beyond simple medication reminders [8] and Design and Evaluation of a Mobile User Interface for Older Adults: Navigation, Interaction and Visual Design Recommendations [9].

On one hand, Design and development of Medication Assistant: older adults centred design to go beyond simple medication reminders [8] shows the importance and relevance of technological solutions at medication reminders while analyses the iterative process of developing the platform following an elderly-centred philosophy.

On the other hand, Design and Evaluation of a Mobile User Interface for Older Adults: Navigation, Interaction and Visual Design Recommendations [9] explores design recommendations at smartphone applications development. This way, good practices and patterns are highlighted in order to adapt successfully interfaces to elderly.

(3) Non-functional properties is one of the most relevant technical point at development. In this case, the system has the challenge of keeping and processing sensible data about the health of elderly thus, the use of external tools and ultimate advances at performance are quite relevant. Next, RoQME Integrated Technical Project is explained as well as the important role it has played at Remembranza Pills.

The RoQME Integrated Technical Project [10,11] has developed a model-driven tool-chain aimed at easing the modelling (at design-time) and the estimation (at runtime) of system-level non-function properties such as safety, performance, resource consumption, etc. Although RoQME is circumscribed to the robotics domain and it builds on domain-specific models, software and tools (in particular, on the SmartMDSD tool-chain), the RoQME team is working on a platform- and domain-independent implementation that will enable monitoring non-functional aspects such as user acceptance, trust and engagement, which could be applied for dynamically adapting the behaviour of the system or for learning how to better interact with the users.

5 Conclusions and Future Works

Nowadays, population is facing a widespread ageing. The increase in population's average age involves society into the challenge of promoting elderly healthcare measures. Many older adults require assistance in the daily routines, specially at drugs management. Polymedicated older people deal with multiple medicine brands with different take hours and several doses. Therefore, it is a difficult context to handle for elderly population, particularly if factors such as solitude or cognitive problems exist. This way, technology is a matching option at helping older people in the management of medicines.

Multiple technological solutions exist in order to support older adults at medicine management. Nevertheless, some solutions imply an effort to users which can be hard to handle by elderly people. Moreover, voice assistants has been a disruptive solution that has drastically changed interaction with devices. This way, this paper purposes a platform based on Alexa voice assistant that enables elderly to know about the medicine prescriptions just using the voice.

Remembranza Pills is composed by three main endpoints: the web platform where medical personnel specify prescriptions data, Alexa Skill which is used by the elderly and the smartphone application that provides the family with monitoring about the taken medicines. These three components conform a solution that helps older adults to remind daily medicine takes.

The Alexa Skill answers the elderly telling him the medication that has to be taken at each time. Therefore, the device speaks in an easy to understand

natural language that allows the user to identify straightforwardly the medicine, e.g "At this time, you have to take a Paracetamol pill, the one from the blue box".

The full platform has been tested in a laboratory context. Researchers and students where involve at several user tests that analysed the usability and response quality of the system. It is quite relevant to assure a successful working before next versions which will be tested with final users in a real context. As a result from the test period, Remembranza Pills keeps an effective working and a successful performance. Nevertheless, several problems where detected. The Internet connection dependency is a critical aspect that can become problematic. Taking into account Alexa needs a constant Cloud connection, the skill will not be operative if there is not Internet connection. As a response to this question, 4IE Project is working at an assistant that helps older adults to remind medications takes using Snips Platform [12]. This voice assistant works autonomously without Internet connection. Thus, this solution can be specially suitable for isolated rural areas where the lack of Internet infrastructure precludes the use of popular voice assistants such as Alexa or Google Home. On the other hand, user tests also showed the need of using additional technologies in order to enable takes notification and proactive speech. Moreover, future works opens these new functionalities.

The future work line in Remembranza Pills platform is encouraging. The new possibilities to improve the working are numerous and involve the system into a better performance. In this manner, there are two main lines which will improve Remembranza functioning: (1) Proactive reminders and (2) Interconnection with other technological devices.

(1) Proactive reminders are one of the main lacks in Remembranza Pills. Due to Alexa development environment, proactive speech is not supported in Alexa Skills. Moreover, it is not possible to interact with the older adult in order to remind proactively the medicine takes. However, as next versions of Alexa development environment are released, this option will be added.

(2) Interconnection with Other Technological Devices. Test process showed that it is relevant to take into account that sometimes the elderly will not be in touch with the Alexa device. This way, additional technologies can be considered in order to remind the elderly about the drugs takes. Smartphones and smartbands can be two main options to notify these events. Moreover, the addition of these elements in Remembranza Pills scheme will improve substantially the performance and will notably reduce possible risks.

Remembranza Pills brings an useful idea that reconcile technology with elders. Voice assistants has teared down the barriers and learning curves through the use of voice and natural language. The disruption of this idea is a great possibility to provide technology of new applications that improve individuals live. This platform is a small step in a strong future work line we expect to build.

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