MR^2: a Mixed Reality Interface for Navigating Medical Records

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ABSTRACT

In this paper we discuss the design and implementation of a preliminary Mixed Reality interface for Microsoft Hololens, supporting medical records retrieval and navigation. The goal is to ease common activities in the dynamic clinical context, using facial recognition and multimodal commands for accessing medical records on the fly through a free-hand interaction.

CCS CONCEPTS

• **Human-centered computing** → **Mixed / augmented reality**; *Gestural input*; • **Computing methodologies** → *Computer vision.*

KEYWORDS

mixed reality, microsoft hololens, facial recognition, clinical records

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1 INTRODUCTION

The availability of commercial headsets such as the Microsoft Hololens[1] is currently enabling developers and designers to create Augmented-Reality (AR) experiences without being bound to the see-through lens metaphor used on mobile devices. Such applications augment user perception and memory, provide contextual information and support hands-free interaction. The aim of MR^2 (Medical Records in Mixed Reality) is creating an interface targeted to medical doctors for accessing the patient's records *while* wandering around the clinic. Wearing the Hololens, the doctor receives timely contextual information triggered by a facial recognition that identifies the patients through the RGB camera. Then, the doctor can visualize and navigate the clinical information through gesture and voice commands, and the holographic interface will display the corresponding information projecting it on the surrounding environment. Our long-term goal is exploiting Mixed Reality (MR) for increasing the doctor's efficiency and effectiveness, seamlessly combining different sources of data and offering decision support working in a hands-free mode.

2 RELATED WORK

One of the most popular AR and MR applications in the medical field is surgery training and planning. For instance, El-Seoud et al. [2] introduced an MR system for noninvasive surgeries planning. Similarly, Morales et al. [4] present an interface for 3D visualization on HoloLens used to guide neurosurgeries, while the prototype proposed by Xie et al. [7] focuses on torso surgery. An alternative application of AR/MR in the medical field is rehabilitation. Riess [5] and Weghorst [6] evaluate the advantages of AR in the treatment of gait problems due to Parkinson's disease, using virtual objects and visual cues superimposed on the surrounding environment. Duff et al. [1] present a novel MR rehabilitation system for improving reaching movements of people affected by hemiparesis providing real-time, multimodal, and adaptive feedback from their movement patterns. Our project targets a different application of MR in the medical setting, supporting the contextual and multimodal retrieval of the patient's record, visualizing the information through multimedia and 3D overlays.

3 THE MR^2 PROTOTYPE

In order to implement the first version of the prototype, we focused on visiting activities on the hospital ward. The doctor, wearing the Hololens, approaches a patient and the system automatically identifies him through facial recognition. Then, it automatically obtains his or her clinical information, collected by the same doctor, other by colleagues or assistants during hospitalization. The doctor browses such pieces of information through a multimodal interface, using gestures and voice commands, while carrying-out the visiting activity, even with busy hands.[2] The first task the application supports is the retrieval of a given patient's medical record in the hospital database. Such a searching task usually requires text entry, which is notoriously difficult using head-mounted displays without using keyboards. In the hospital ward visiting scenario, the doctor inspects the medical record on the fly while talking with the patient. Therefore, we exploit facial recognition for performing this search: exploiting the Hololens RGB camera, the application detects and classifies the faces in each frame. The interface informs the doctor about the recognition process through the colour of the detection

[1] https://docs.microsoft.com/en-us/windows/mixed-reality/hololens-hardware-details

[2] A video showing a sample interaction with the application is available at https://youtu.be/s4U7GuC1a-o

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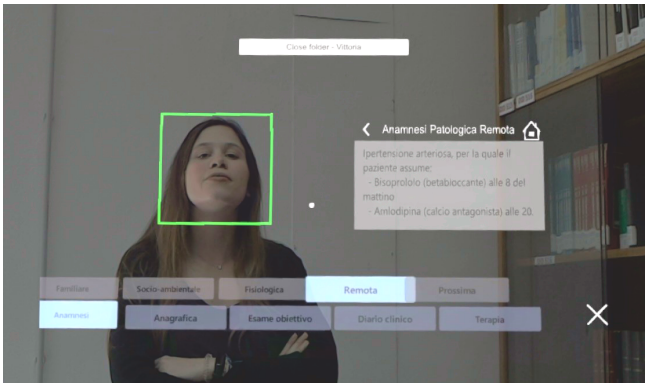

Figure 1: The Mixed Reality interface for browsing medical records. The system draws a green rectangle on the identified person's face. The doctor selected to browse her pathological history (*Anamnesi* in Italian) and then the remote past group at the local-navigation level (*Remota* in Italian). The box on the upper-right part of the interface shows the record contents and contains both the back and home buttons for a fast recovery from selection errors.

bounding rectangle (a rectangle that surrounds the face, see Figure 1). The green colour means the patient is on the list, while a red box means a not identified person. If the application recognizes a person, the interface shows a label with his name. Selecting such label the doctor confirms the intention to navigate his/her medical records. If a person was not recognized, the resulting label will be a question mark. The doctor can explicitly specify his name through a virtual keyboard or the voice modality. This will add the acquired frames to the face recognition training set and it will associate the corresponding medical record to the new samples. In case more than one person was detected, the doctor will see more than one bounding rectangle. He can select which medical record to open simply gaze-pointing one persons' bounding rectangle and confirming the selection through a tap gesture. We will consider more disambiguation options in the future.

Once the medical record has been retrieved, the recognition process stops and the interface shows it as depicted in Figure 1. We render the interface using the doctor's frustum as its reference coordinate system (tag-along in the Hololens jargon): the interface holograms are bound to the user's point of view and the doctor can freely move inside the surrounding space followed by the dynamic canvas. The interface has been designed in order to be clear and understandable to the user, adapting the structure of the printed medical records in use. It splits the data on two navigation levels: i) the global that includes the high-level groups and ii) the local, showing sub-categories of the selected global item. The global level recalls the existing sections in the printed medical records, corresponding to the bottom row in Figure 1. Once the user selects the global item, the interface shows the local navigation in the upper row, whose groups depend on the main item. The button colors, shape and fonts comply with the best Hololens design practices [3]. For instance, background and text colours have contrast for supporting label reading when the interface is overlayed on the real world. The selection of the items exploits the gaze-pointing. A size-increasing animation guides the process, highlighting the hovered item. The user confirms the selection of an item through a tap gesture, or by pronouncing the correspondent item label. Once the user selects an item, it will maintain the larger size and a brighter colour. The remaining element will be rendered using in a darker style. Such colour scheme supports an easier identification of the selected elements when rendered on the holographic screen: darker element are less opaque and they will not occlude the real-word image. The tool tries to support an efficient and effective navigation. Doctors can switch easily between panels, buttons and navigation levels since all buttons, even if de-highlighted, respond to the user's selection both through gestures and voice commands. The doctor can easily close the current medical record by selecting the X button in the bottom-right part of the interface or, equivalently, through the heading label ("Patient name - Close folder").

MR^2 is Windows Holographic Platform application developed in Unity, which exploits the standard interaction capabilities supported by the development framework (head tracking, gaze pointing, gestures and vocal input). The face recognition support was developed using OpenCV.

4 CONCLUSIONS AND FUTURE WORKS

In this paper we discussed a first prototype implementation of MR^2, a mixed reality application for supporting doctors in navigating medical records. The application exploits different modalities and contextual information for supporting a free-hand interaction while carrying out visiting activities in a hospital ward. In the future, we will add more complex data visualizations for such records (e.g., localized information on the patient's body), and we will refine the gestural interaction. In addition, we are going to collect real doctor's feedback organizing interviews and focus groups where we would try to let them experience the interface and collect qualitative feedback for further design iterations.

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