Preserving Conversations with Contemporary Holocaust Witnesses

Evaluation of Interactions with a Digital 3D Testimony

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ABSTRACT

Conversations with Holocaust survivors are an integral part of education at schools and universities as well as part of the German memory culture. The goal of interactive stereoscopic digital Holocaust testimonies is to preserve the effects of meeting and interacting with these contemporary witnesses as faithfully as possible. These virtual humans are non-synthetic. Instead, all their actions, such as answers and movements, are pre-recorded. We conducted a preliminary study to gauge how people perceive this first German-speaking digital interactive Holocaust testimony. The focus of our investigation is the ease-of-use, the accuracy and relevance of the answers given as well as the authenticity and emotiveness of the virtual contemporary witness, as perceived by the participants. We found that digital 3D testimonies can convey emotions and lead to enjoyable experiences, which correlates with the frequency of correctly matched answers.

CCS CONCEPTS

• **Human computer interaction (HCI)**; • **User studies**; • **Natural language interfaces**; • **Education**; • **Sociology**;

KEYWORDS

Voice-user interaction, Digital interactive testimony, Stereoscopic 3D, Immersion, Emotiveness, Holocaust education

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1 INTRODUCTION

The celebrations of the 75th anniversary of the Victory in Europe Day on May 8th, 2020, signifying the end of World War II in Europe, highlighted two important issues regarding Holocaust education. On the one hand, speakers like Germany's head of state President Frank-Walter Steinmeier warned, among other things, against "a new brand of nationalism", "hatred and hate speech" and "xenophobia" [1]. President Steinmeier echoed a famous speech his predecessor Richard von Weizsäcker gave exactly 35 years before for the same occasion [2], both calling for unity, admission of responsibility, and continued remembrance. The need for a lasting memory culture in Germany also emerges in the face of ongoing antisemitism [3], the surge of right-wing populism [4, 5], and the trivialization of the Holocaust by elected officials [6–9]. On the other hand, 75 years represent a significant length of a lifetime. Infants born in concentration camps in the last months of World War II are senior citizens nowadays, teenagers and young adults at the time are currently approaching and even surpassing 100 years of age. Their advanced age increases the physical and mental toll of visiting schools, museums or memorials to recount their experiences. These face-to-face meetings and conversations with Holocaust survivors are an integral part of citizenship education in Germany. However, in the not so distant future, no first-hand witnesses of the Holocaust will be left to tell their story in person. The aforementioned 75th anniversary of the Victory in Europe Day, as well as 2020's anniversaries of the liberation of concentration camps like Dachau [10] and the ceremonies of the Holocaust Remembrance Day [11], gave a glimpse into this future: Health concerns due to COVID-19 made gatherings with Holocaust survivors, who are highly at risk, no longer justifiable.

Future generations of students will have to rely on second-hand testimonies or recordings to learn about the Holocaust [12]. Similarly, a complete lack of Holocaust survivors and first-hand witnesses might impede opposition to Holocaust denial as well. In 2020, Zick et al. [13] documented a sustained high level of interest among Germany's youth to critically examine the nation's role in World War II. However, findings also show that younger Germans have less and less access to and, thus, contact with contemporary witnesses. Even across all surveyed ages, 64.4% have never spoken with contemporary witnesses about their experiences during World War II. Two surveys organized by the Claims Conference [14, 15] yielded similar results for the United States of America. Zick et al. also found many negative correlations between nationalist or history-trivializing tendencies and affinity to history education or remembrance. Therefore, each passing day increases the necessity to preserve conversations with contemporary witnesses as faithfully as possible.

The USC Shoah Foundation undertook the first innovative steps as part of their Dimensions in Testimony [16]. They succeeded in creating the first interactive Holocaust testimonies, which are currently presented in selected museums. Our project Learning with digital testimonies (LediZ) [17, 18], however, aims to additionally make interactive testimonies available for use at German schools.

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To this end, LediZ is a cooperation between the LMU Munich, the Leibniz Supercomputing Centre, and the Forever Project. The Forever Project [19] previously assisted the National Holocaust Centre and Museum with their own takes on digital interactive Holocaust testimonies [20]. We were able to convince the Holocaust survivors Abba Naor and Eva Umlauf to support this project by lending their story and their likeness to each of their respective interactive virtual twins. We aim to increase the engagement and immersion of users by displaying the interactive testimonies in stereoscopic 3D.

In this paper, we will present and discuss a preliminary study on the current state of the digital testimony of Abba Naor. The study focused on the interaction design, the matching accuracy as well as the emotiveness and immersiveness of the chosen design.

2 RELATED WORK

The first implementations of artificial dialogs with virtual humans date back as far as 1998: Marinelli and Stevens [21] recorded an actor disguised as a historical figure answering questions about the portrayed person's life. Afterwards, they categorized and indexed the video files. This database served as a searchable library of answer videos. Their setup furthermore included a speech recognition system as well as a natural language processing (NLP) model. This combination enabled users to ask verbal questions, which would then be analyzed for specific keywords and assigned a suitable answer video, thereby simulating a conversation. The authors also used specific videos to fill the idle time between the end of an answer and the beginning of the next question with a livelier portrayal of the character as opposed to using a still image. In order to deal with questions for which the program is unable to provide a suitable answer, Marinelli and Stevens established a pool of generic responses. The failure to find an answer could result from either speech recognition errors or the absence of a suitable video file. The former cases caused the virtual character to request the user to rephrase their question, while "out-of-bounds" questions were met with an attempt to direct the user to another topic. This concept, consisting of an indexed collection of previously taped separate response videos, speech recognition, language processing models, idle loops, and dedicated videos to handle unserviceable input, serves as a foundation for most modern interactive virtual testimonies, including the LediZ project.

Traum et al. [22] successfully applied this idea to Holocaust education by adjusting a few details: First, instead of actors imitating the historical figure, they filmed the real contemporary witness. Second, they introduced a systematic sourcing and ranking of potential topics and questions before the videotaping of the survivor. Third, with almost two decades of technological progress since the installation by Marinelli and Stevens, Traum et al. could rely on more efficient and capable hardware and software. This led to higher audio-visual quality capture methods and displays, a more robust speech recognition and matching process, as well as the preparedness for use in stereoscopic 3D displays. For example, a study by Yang et al. [23] found that showing videos in stereoscopic 3D results in increased perceived immersion at the cost of an increased risk of motion sickness. The authors note that these can be attenuated with increased distance from the display. Since conversations with Holocaust survivors abstain from including rapid movements or changes in perspective, the use of stereoscopic 3D in this context minimizes these negative effects.

The usage of virtual conversation techniques to explore testimonies of Holocaust survivors aims to curb an issue of Holocaust education pointed out by Gray [24]: "One of these dilemmas is the dissemination of such an abundance of testimony material". As an example, the author details the Tree of Testimony [25] at the Los Angeles Museum of the Holocaust. The installation includes 105 000 hours, almost twelve years, of videotaped testimonies. The sheer amount of data makes meaningful search and navigation methods, like the aforementioned voice input, necessary. Frosh [26] raises a further point in support of interactive testimonies: Well-designed user interfaces for navigating testimonies make it easier to use and, thus, access survivors' life stories. He argues that simple interaction designs strengthen the involvement of the viewer. The removal of technological hurdles, in turn, reduces a decision against co-witnessing to a moral decision of unwillingness: If interacting with the testimony is easy and accessible, the reason for not interacting would stem from indifference or even aversion to the topic.

Since the pool of answer videos is finite and determined by the questions posed during the filming process, the potential knowledge gain obtained from a captured testimony is limited. For example, a question which is frequently asked by users and which the virtual witness is unable to answer satisfyingly, makes the possibility of synthesizing new responses appealing. A possible approach could be the use of artificial intelligence to create new video and audio tracks based on the captured media and available data surrounding the Holocaust survivor. An alternative would be the creation and animation of a 3D computer graphics model of the survivor for possible future use [27]. We opted against these methods, as artificial humans tend to be perceived either as abstract and unrealistic or realistic, but uncanny [28, 29]. The existence of an audio-based uncanny valley reinforces these issues [30]. The ongoing improvement of deepfakes [31], however, could create convincing synthesized answers. Yet, even without perceptive challenges undermining the effect of a virtual contemporary witness, artificially generated answers could risk the credibility, fidelity, and validity of the entire testimony. Therefore, we decided against amending the pool of answers.

An up-and-coming approach is capturing humans in realistic volumetric 3D [32], with the Fraunhofer Heinrich Hertz Institute, in cooperation with the UFA, already exploring ways of digitally preserving Holocaust survivors in this manner. Feiler et al. [33] describe a volumetric collection of six short interviews of Ernst Grube by a student. They intentionally included the student in the captured material as a representative of the intended main audience. The authors propose placing each interview in a virtual environment relevant to the respective topic. We find this technology as well as the addition of virtual historical surroundings very promising. However, in this current implementation the lack of speech input and the use of a virtual representative restrict its interactivity and immersiveness.

Additionally, the complexity of capturing and post-processing of the contemporary witness limits the length, and thus the number of topics, of the potential recording more than the previously

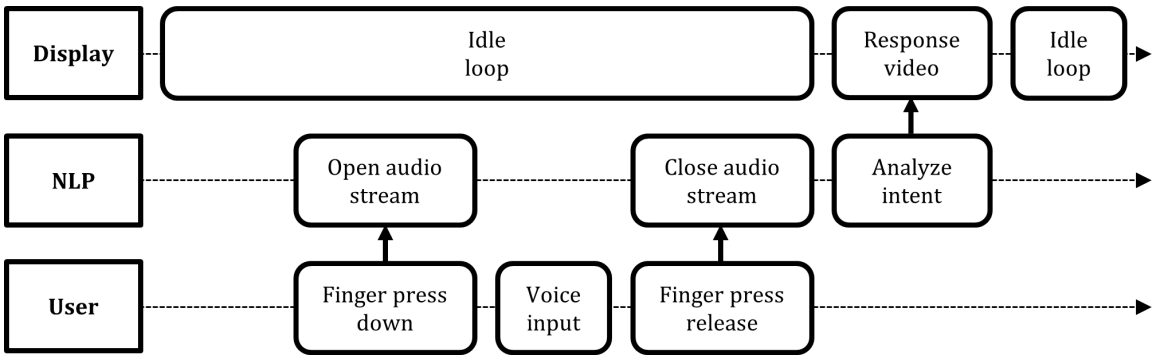

Figure 1: Interaction sequence for the digital testimony's reaction to verbal user prompts.

mentioned approaches for virtualizing a conversation with a human being.

3 CONCEPT AND IMPLEMENTATION

To create a lifelike digital copy of a living human being, we opt to use stereoscopic 3D. Displaying two slightly different video streams, one for each eye, with their perspectives offset by the mean interpupillary distance, provides a more detailed and immersive visual experience due to the added dimension and depth. This approach, however, causes increased demands for displaying the video data, as it requires installations which are capable of delivering separate pictures to each eye. A common implementation is the temporal or polarized overlay of both streams on a single screen. 3D-glasses equipped with shutter functionality or polarization filters, respectively, are then used to separate the images for each eye. The doubling of the video information is an additional challenge, since it also results in a duplication of the data load. This can lead to bottlenecks and possible delays, depending on the quality of the connection to the data location and the decoding time on hardware. In case these requirements prove to be too limiting in practical use, it is possible to fall back on conventional 2D display techniques. As the separate video streams are already captured separately during filming, we can readily convert from 3D into 2D by filtering the streams intended for one eye. We adjust the respective display so that the virtual human is shown in natural size.

The interactivity of the digital testimonies derives from the virtual human's ability to respond to prompts by users, preferably voice input. This process is detailed in Figure 1. In the initial system state the 3D display shows an idle loop, which is a seamlessly repeating short video of the virtual human anticipating a query. If a user wants to pose a question, they need to push and hold a button on a mobile device. The application on the smartphone has two states: idle and recording. A finger press anywhere on the screen switches from idle to recording, while lifting the finger returns the input device to the idle state. A change in background color from black to blue serves to confirm the state change to the user. Instead of waiting for the voice recording to end, it is continually streamed to the NLP component. This aims to shorten the waiting time between the end of the question and the beginning of the response. The recording is thus continually evaluated until the audio stream is closed. The NLP system subsequently finishes its analysis of the intent of the question and causes the displayed video to transition to the most fitting answer video. If no suitable answer for the input is found, the virtual contemporary witness asks the users to rephrase their question. After the virtual response finishes, the display resets and returns to the idle loop.

In order to create a meaningful and varied experience to the users, we recorded answers to more than 1000 questions covering all chapters of the life of the contemporary witness over five days. The questions were sourced from books and documents about the witness' life as well as recurring questions during conversations between students and the Holocaust survivors. We then individually ranked the questions on behalf of their respective likelihood of being asked and the semantic value of their prospective answers.

4 RESULTS AND DISCUSSION

We surveyed 46 German-speaking participants in the study over a period of two weeks in February and March 2020. The imminent threat of SARS-CoV-2 and the resulting federally imposed restrictions on public life, however, required a discontinuation of further scheduled surveys during 2020. Of the 46 people surveyed, 43% identified as female, 57% identified as male, and none as non-binary. The age of our user study participants ranged from 13 years to 63 years, with a median of 25.5 years. More than 90% reported at least a fair amount of interest in topics related to the Holocaust and, thus, have previously pursued these topics voluntarily during their own spare time. This high percentage at least partially stems from the inclusion of Holocaust Education in the German school system [34]. Furthermore, 28% of the people surveyed had personally interacted with one or more Holocaust survivors, either within their own family, among their acquaintances, or as part of their education. Before engaging with the digital Holocaust survivor, only one-in-seven had already experienced digital historical testimonies, for example, in the form of Instagram stories.

4.1 Study Design

We provided each participant with a printed short summary of the most significant stages in the life of the Holocaust survivor. We chose a short and compact handout over a more detailed insight into his life story in the form of a previously captured 41-minute narrated video of the witness himself. This gave the participants more time to spend asking questions as well as an always-accessible

Table 1: Perceived quality of user interaction (n = 46).

Topic	Very good	Good	Fair	Poor	Very poor
UI design	78.3%	21.7%	0%	0%	0%
UI understandability	71.7%	19.6%	8.7%	0%	0%
App robustness	60.9%	8.7%	15.2%	10.9%	4.3%
Overall ease of use	69.6%	19.5%	10.9%	0%	0%

Figure 2: A life-size virtual testimony by Abba Naor (right) displayed on a powerwall. The user (left) is able to ask questions with the help of a smart phone.

structured overview of possible topics of conversation. Several participants, however, later noted that they would have preferred the more detailed account by the digital witness. They remarked that an introductory narration by the virtual conversational partner would help ease their tension and also supply them with a wider range of ideas for potential questions. We gave each participant polarized 3D glasses, which were necessary to experience the contemporary witness in 3D. We also provided the mobile input device for the test persons to use and share (see Figure 2).

After a brief explanation on how to use the system, all participants spent 25 to 35 minutes questioning the digital testimony. We did not interact with, interfere with or limit the test persons during this process, except for technical support on demand. Subsequently, we asked the participants to report their impressions and reception of the interactive digital testimony in a questionnaire. Our questionnaire consisted mainly of Likert scale questions [35] with the option of adding comments in open text fields. For each resulting set of data, we also provide the cardinality n of the respective set, as some participants did not answer every question included in the questionnaire.

4.2 Questionnaire Results

The first key aspect of our evaluation targeted the app design of the mobile input device. The results, which we detailed in Table 1, show a high degree of satisfaction among the users. This especially relates to the simplicity of the interaction process as well as the user interface (UI). Three participants voiced their dissatisfaction with the stability of the application. These cases were caused by a fluctuation of the delay between end of the user's input and the start of the reply video by the digital testimony. The application itself, however, is rarely the cause for these fluctuations, as there are several interlocked components and systems between initial input and final output at play. More likely sources for fluctuating delay include the streaming server, the matching system, or the network connecting the modules.

The second subject of the questionnaire dealt with answers given by the virtual human. A dedicated prompt regarding the perceived matching accuracy showed that the responses given by the virtual contemporary witness were suitable to the majority of respective questions (see Table 2). The overall matching accuracy during our study averages out at 63%. We rate this portion of fitting answers as insufficient, as the LediZ project aims for a lower bound of 90%, which would guarantee a more satisfying conversation. Additionally, we found that, concerning the perceived quality of the dialog, 15% of participants were satisfied with the answers given, while 22% were dissatisfied. However, 30% reported that the given responses fit the core of their questions, and 15% found the answers not fitting overall. More than 80% found that the answers also included further details not directly relevant to the question. Nonetheless, 89% also considered these details to be of great interest. Regarding the length of the given answers, 80% would dislike shorter answers, whereas a proposal of longer answers was met with ambivalent feedback. Thus, we can conclude that the captured footage of the witness' replies, with 84% of the answers taking less than 60 seconds, is fitting. However, this result can also be attributed to the witness' multiple years of refining experience of answering questions about his life. Seven-in-ten people surveyed confirmed that they perceived the emotions of the Holocaust survivor, which were evoked by his recollection. Moreover, 41% felt like they were talking to and interacting with a real human being. Reminiscing on the answers given by the digital testimony, 26% reported having learned substantial new details on the Holocaust, while 29% reported little to no new insights. A large majority of the participants (88%) are in favor of the future use of interactive stereoscopic digital Holocaust testimonies in museums or schools on a regular basis. The dissenting participants cautioned that any technical shortcomings causing an unsatisfactory answer to be played would reflect badly on the original real human instead of the system. They added that this could tarnish the legacy and impact of the contemporary witness. This is also corroborated by linear correlations between participants receiving fitting or interesting answers and the same participants supporting broader and more public availability of the interactive digital 3D-testimony.

We asked the study participants to rank their subjective significance of the four main characteristics of the interactive stereoscopic digital Holocaust testimony: Response pool, 3D effect, visual quality, and ease of use. The results are detailed in Table 3.

The aspect which was classified as most important, by far, is a large pool of possible responses. The feature considered least

Table 2: Perceived quality of the dialog (n = 46, with the exceptions of n (Details were of interest) = 45, n (Gained knowledge) = 45 and n (Use in public institutions) = 43).

Topic	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Satisfied with answers	2.2%	13.0%	63.0%	19.6%	2.2%
Fitting responses	4.4%	26.1%	54.3%	13.0%	2.2%
Responses added details	21.7%	60.9%	8.7%	8.7%	0%
Details were of interest	44.4%	44.4%	8.9%	2.2%	0%
Gained knowledge	8.9%	17.8%	44.4%	26.7%	2.2%
Shorter answers preferred	0%	10.9%	8.7%	45.6%	34.8%
Longer answers preferred	10.9%	17.3%	43.5%	26.1%	2.2%
Survivor showed emotions	41.3%	28.2%	19.6%	4.4%	6.5%
Survivor felt like a real human	15.2%	26.1%	39.1%	10.9%	8.7%
Use in public institutions	62.8%	25.6%	6.7%	2.3%	2.3%

Table 3: Subjective ranking of importance of features (n = 43). Normalized columns due to tied ratings by participants.

Topic	Most important	Important	Less important	Least important
Response pool	69.6%	8.9%	0%	15.0%
3D effect	13.0%	11.1%	24.4%	55.0%
Visual quality	4.4%	46.7%	37.8%	12.5%
Ease of use	13.0%	33.3%	37.8%	17.5%

important out of the four was the 3D effect. Nevertheless, it also received the second most "most important" votes, along with Ease of use. The test persons valued both visuals and usability, ambivalently. These results raise the question of the practical benefit of the stereoscopic 3D effect.

Interactive 3D testimonies featuring different contemporary witnesses, for example perpetrators, could lead to differing effects. Similarly, users who are skeptical of or opposed to the content of the respective digital testimony might react dismissively.

5 CONCLUSION AND FUTURE WORK

We detailed the first assessments of the first German-speaking digital interactive Holocaust testimony within the scope of a preliminary user study. We focused on evaluating the chosen technical implementation: the quality of the user interaction, the emotionality of the virtual human, as well as the accuracy of the system matching answers to spoken questions. Our results can assist in the design, implementation, and evaluation of further digital testimonies, as well as the refinement of existing virtual contemporary witnesses.

We found that the user interface and the interaction itself is regarded as easy to understand and use. This characteristic is crucial for an application aiming for acceptance and adoption by people of different backgrounds, ages, or levels of education. The study participants found the answers satisfactory overall. However, we have identified that shortcomings in the matching system strongly negatively impact the general acceptance. Flaws of the system can discourage the user from interacting further or even strain the impression of the real contemporary witness. Improvements and adjustments in this sector could lead to a higher accuracy and, therefore, a far more satisfying experience. Similarly, the quality and quantity of the answer pool is essential to a satisfactory interaction. The initial selection of questions is significant, since capturing and adding more answers at a later date while also preserving continuity between these recordings is extremely difficult. We also learned that many of our study participants would prefer an introductory video of the virtual human explaining their own story. This would also help setting the tone and help the users overcome initial reservation. In summary, the present version of the digital interactive Holocaust testimony of Abba Naor is well received, with a strong support for use in educational and cultural facilities.

During the evaluation we recognized the need for a separate study focusing on the advantages and disadvantages of stereoscopic 3D testimonies as opposed to monoscopic 2D testimonies in the context of learning, immersion, and emotiveness. We have also identified the application's reliance on a strong internet connection as a possible limitation, as many public schools and museums lack dependable Wi-Fi. A partial solution to this issue is the use of locally stored video data as opposed to video streaming. We will use such a portable setup to conduct comparative study on the effect of digital testimonies in contrast to the effect of the interaction and conversation with real Holocaust survivors in order to help to quantify their differences and respective benefits.

We also intend to create and evaluate further digital interactive 3D testimonies of other population groups. A broader variety of diverse interactive testimonies will facilitate identifying and comparing the effects of increased immersion, fidelity, and emotiveness on prospective users.

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