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# Poster: An exploratory analysis to elicit requirements for avatar-based interfaces aimed at the deaf community

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This article describes an exploratory analysis aimed at defining user experience (UX) guidelines for avatar-based interfaces targeting the deaf community. The LIS4LL software, a program for the automatic translation from Italian to LIS (Italian Sign Language) in the railway domain, is used as a prop to elicit user requirements. LIS4LL was developed, in prototypical form, thanks to the support of European funds and the collaboration of numerous academic and industrial partners. The objective of this analysis, conducted using a questionnaire distributed to 63 participants with varying degrees of deafness, is the investigation of the strengths and weaknesses of the software from the UX point of view. Particular attention is devoted to the perception of the avatar and to the transmission of content that does not have an equivalent in LIS, as is the case with the names of many stations. Here we discuss the results of our analysis, with the aim of offering useful hints for the improvement of a technology capable of breaking down language barriers, favoring and promoting social inclusion.

CCS Concepts: • **Human-centered computing** → **Accessibility technologies**; **Empirical studies in HCI**.

Additional Key Words and Phrases: Survey, Technologies for social inclusion, Avatar-based interface, Italian to LIS translator

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## 1 INTRODUCTION

The LIS4ALL project<sup>1</sup> was born in 2012 with the specific aim to produce a SOTA system to enhance information sharing in public spaces. The project produced a software prototype that translates spoken Italian into Italian Sign Language (LIS), the language used by the Italian deaf community. The prototype consisted of a virtual character (Figure 1) capable of executing automatic translations in the domain of the Italian Railway Network (RFI)<sup>2</sup> [4, 6, 7].

Over the last ten years, the opportunities offered by digital technology to facilitate communication between Deaf and hearing people have increased significantly, witnessing a society that is attentive and open to the other and to diversity. However, there are few cases in which the tools designed have been subjected to a user-centered design process and evaluation, capable of highlighting the propensity to use, perceived usefulness and functionality, and aesthetic and emotional aspects. The main goal of this work is to use the LIS4ALL prototype as a prop to elicit user requirements

<sup>1</sup>LIS4ALL PROJECT, POR FESR 2007/2013, Asse I, Attività I.1.3, [https://poloinnovazioneict.org/en/projects/lis4all\\_polito-2/](https://poloinnovazioneict.org/en/projects/lis4all_polito-2/)

<sup>2</sup>Example of voice announcement at the railway station: The regional fast train, 20 05, Trenitalia, 6:53 a.m., for Milano Centrale is leaving from platform 12. LIS translation: Trenitalia Fast train, platform number 12, number 20 05, 6:53 a.m., Milano Centrale go, leave shortly

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for the design of avatar-based interfaces aimed at facilitating the communication and daily activities for deaf people. In particular, we want to highlight aspects that can affect the *perceived usefulness*, but are not strictly related to the objective quality of the translation [4].

Two related works have strong connections with our research: the BlueSign-2 system and the study by Eblin [5]. The BlueSign-2 system consists of a handheld computer capable of translating Italian texts into the Italian Sign Language (LIS) and providing the translation through the real-time animation of a three-dimensional figure [1–3]. The prototype, built with the help of a deaf person, was subjected to constant supervision of the end users during the development phases and the working model was also shown to deaf people of different ages and cultures in order to have as realistic a feedback as possible. As for [5], it concerns the evaluation, through a focus group with seven deaf people, of an avatar that translates notices in the Swiss Federal Railways into German Sign Language.

## 2 METHODS

Around ten meetings with various professionals and experts in the project’s domains of interest (linguists with particular expertise in sign language, human-computer interaction and nlp experts) were carried out to detail the objectives of our analysis. Four areas of interest emerged (appearance of the avatar, movement of the avatar, sign sensitivity and usefulness of the software), and it was specified that only deaf signers would be involved in the study, as they constitute the target population of the LIS4ALL software.

An online survey, conducted anonymously, was considered the most suitable tool, a choice motivated by considerations of the accessibility of the tool itself and the desire to reach a relatively large number of participants (target: at least 60 respondents [5]). The survey, introduced by a written presentation of the study and the informed consent form, both supported by an explanatory video in LIS to make the content of the two documents more comprehensible to participants, was structured as follows: the first part, relating to the LIS4ALL software, was subdivided according to the areas of interest identified (each of which was introduced by a video demonstration of the software) and consisted of 20 closed questions to be answered through a Likert-like scale (4 on appearance, 4 on movement, 8 on sensitivity and 3 on usefulness and a general question on the respondents’ personal opinion of the prototype) and 5 open questions, intended mainly to collect free suggestions and proposals for improvement. A second optional part included 9 questions on the respondents’ medical history (gender, age, unilateral or bilateral deafness, degree of hearing loss according to the BIAP<sup>3</sup> classification, time of onset of deafness, age of first exposure to LIS, use of hearing aids and contexts of LIS use) for a total of 29 questions<sup>4</sup>.

As for participants recruitment, the Lavazza<sup>5</sup> company allowed us to administer the questionnaire to deaf employees hired at one of its plants. Other participants were reached via snowballing and from personal knowledge of Irene Mazza.

The study was approved by the Bioethics Committee of the University of Turin<sup>6</sup> (Prot. no. 0582713 of 21/11/2022).

The distribution of the questionnaire started on 23 December 2022 and ended on 31 January 2023; 63 responses were collected. We obtained a very interesting sample from our point of view, since both age, degree of hearing loss and period of initial exposure to LIS, all essential elements to better understand users’ evaluations of the usefulness of the LIS4ALL software, are quite heterogeneous. As far as age is concerned, in fact, 6.5% of participants are between 18 and 25 years old, 22.6% between 26 and 35 years old, 40.3% between 36 and 50 years old and 30.6% over 50 years old. With regard to the degree of hearing loss, 47.5% of the participants said they had profound deafness, 28.8% total deafness,

<sup>3</sup>Bureau International d’Audiophonologie (Lisbon, 1st May 1997)

<sup>4</sup><https://docs.google.com/forms/d/e/1FAIpQLSc0jBBqQwetR12pBFypux4MJE9ykasObVV886BNgHWbjwPZkw/viewform>

<sup>5</sup><https://www.lavazza.it/it>

<sup>6</sup><https://www.unito.it/>

20.3% severe deafness, 3.4% medium deafness and 0% mild deafness. Finally, only 28.8% of the participants had been exposed to LIS from birth.

### 3 RESULTS

Some particularly interesting results emerged from the survey, which we report below.

**Appearance of the avatar.** The participants' answers show a general liking: in particular, the physical appearance was considered fairly realistic by 54% of the respondents, very realistic by 7.9% and extremely realistic by 3.2%. The colours of the clothing were considered fairly pleasant by 44.4% of the sample, very pleasant by 19% and extremely pleasant by 3.2%.

The above quantitative results can be better understood if taken together with users' considerations emerging from open questions, which help to identify areas of improvement.

In particular, participants provided suggestions regarding clothing (P2<sup>7</sup>: *I recommend the use of a shirt with long sleeves and without the label on the chest*; P29: *I recommend the use of a uniform consistent with the context, it would be more refined, more elegant*) and the use of colours (P54: *Well done but, I would use other colours. Grey is, without a doubt, a colour that conveys calm and balance but I would reinforce the image with brighter colours that would attract attention but, at the same time, not tire the eyes*).

The use of a neutral colour for the background was particularly appreciated, as it was considered very pleasant by 28.6% of the respondents and extremely pleasant by 4.8%. Nevertheless, the analysis of the open-ended answers revealed some suggestions that could be useful for avatar designers. In general, participants seem to recommend a better contrast with the foreground character (P3: *I would recommend improving and/or changing the background colour by differentiating it from the avatar*; P28: *The background would be better black or white*; P33: *The background should be light grey*).

On the other hand, concerning the realism of the NMCs (Non-Manual Components), i.e. all those elements related to facial expressiveness, lip movement, and body movement that accompany the execution of a sign, participants were not completely satisfied. In fact, 28.6% of the sample only slightly agreed with the statement "The NMCs (Non-Manual Components) are realistic", and 15.9% did not agree at all. Open user comments show that the parameter of NMCs is essential to the correct understanding of the message (P12: *The avatar doesn't use facial expressions, so you can't understand it. Looking at the video of the avatar, I struggle to understand what it is saying*; P28: *Very nice, but facial expressions are missing*; P32: *I like it but it lacks facial expressions and lip movements which I would need*; P45: *For us, the important elements are facial expressions and lip reading. Here I find them very little*).

**Movement of the avatar.** To this regard, it is particularly interesting to compare the reactions to the statements "The avatar signs too fast" and "The avatar signs too slow" because, contrary to our expectations, the data are almost equivalent, as shown in Table 1.

We surmise that participants in different age groups might have opposite opinions about this aspect: thus, we are planning to compare the answers of "young" and "old" participants to verify our idea and, possibly, provide suggestions to personalize the avatar design for different target groups.

**Sign sensitivity.** Respondents highly appreciated the use of a road-like sign, displayed in the overlay by the avatar, to indicate stations that do not have a sign name (Figure 1).

In this context, road-like signs are a unique and innovative element replacing translation by typing.

<sup>7</sup>Participants were assigned anonymous codes (P1, ..., P63), which will be used from now on when reporting their comments.

Options	the avatar marks too slowly	the avatar marks too fast
Not at all agree	31.7%	36.5%
Slightly agree	27%	28.6%
Somewhat agree	31.7%	27%
Very much agree	6.3%	4.8%
Strongly agree	3.2%	3.2%

Table 1. Comparison of frequency distributions of two opposite statements.

More specifically, the majority of answers indicates that the solution was appreciated (36.5% very much agreed, and 22.2% agreed) and only a minority find it either not very useful (15.9%) or not useful at all (3.2%). To make the software even more useful and usable, one of the participants suggested combining the road-like sign and name-sign, when possible (P20: *Some cities have the name-sign. The avatar could mark the name of the city and be accompanied by the overlay sign*).

**Usefulness of the software.** Participants’ feedback to this regard is extremely positive: in fact, most respondents (28 people, 44.4% of the sample) very much agree with the proposed statement (“LIS4ALL software can be useful to the deaf community”), followed by 14 people (22.2%) who say they somewhat agree, 12 people (19%) who say they strongly agree and only 9.5% (6 people) and 4.8% (3 people) who agree slightly and not at all, respectively.

Open comments also testify a high degree of appreciation for the LIS4ALL software (P3: *I would say that it is well implemented and would be very useful for deaf people who could be autonomous and informed about the notices without having to ask the railway staff directly considering also that in smaller stations the staff is often not there*; P5: *The project is very ambitious. The idea is really good. It would help a lot of those people who don’t understand oral announcements and even worse the unexpected things that can happen*; P8: *It is a very good first step towards accessibility*; P14: *It is very useful for all deaf people*; P18: *I think the use of the avatar greatly facilitates understanding in situations that might bring discomfort to the deaf community. The videos I saw in the survey were well developed, I notice that there was attention to the signs whether understandable or not*; P39: *It is a good proposal. This project would be useful for us deaf, for our autonomy*; P57: *For me, it is very useful, it helps us to collaborate. Thank you!*; P62: *Very interesting, especially when track changes at the last moment and delays are announced*). Not only was the software usefulness recognized, but its applicability in contexts other than railway stations was also positively assessed by 65.1% of the sample (41 out of 63 participants). Other possible contexts suggested by participants are: hospital (11 persons), airport (10 persons), bus station (3 persons), post office (3 persons), public office (3 persons), bank (2 persons), places with voice announcements without a display (2 persons), underground (2 persons), school (2 persons) and then church, naval port, INPS, court, factory, workplace, condominium meetings and waiting rooms.

Considering the long list of recommended places allows us to understand how many places, which are relevant to deaf people’s everyday lives, do not adequately meet their needs. In addition, these suggestions highlight the fact that the LIS4ALL software would be welcome in very different contexts.

#### 4 CONCLUSION

Based on our exploratory analysis, which used the LIS4ALL software as a prop to elicit requirements for avatar-based translation interfaces from spoken languages to sign languages, we propose the following guidelines:

- (1) Make the avatar as similar as possible to a human person in both its appearance and its movements, by paying particular attention to fluency, speed, and rhythm in the execution of a sign sequence.

- (2) Make facial expressions and lip movements easily detectable and unambiguous.
- (3) Provide a good contrast between the background and the foreground character.
- (4) Use signs that are not subject to regional dialect inflections.
- (5) Add subtitles.
- (6) Use road-like signs to convey spoken-language words which do not have a corresponding name-sign.

The purpose of sharing the suggestions that emerged from this analysis is to highlight certain aspects that could guide the design of new avatar-based interfaces, both from an aesthetic and usability point of view and in line with the results of other studies [5]. It is also worth noting that our results show that the LIS4ALL prototype, a software produced with a 10-year-old avatar technology, was still evaluated positively on the whole. Hence, we are planning to report these results to the stakeholders, so as to encourage the resumption of the project and, in particular, the involvement of deaf users in the design process. Above all, we hope to have contributed to raising attention to a minority that needs to be heard and welcomed in a society that can be truly accessible and inclusive.

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Fig. 1. Indication for Rebaudengo Fossata, a lesser-known station in Turin without a name-sign [6, 7]