MAKING AIRPORT SECURITY ACCESSIBLE TO THE DEAF

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ABSTRACT

Those with disabilities have always had difficulty navigating airport security measures. In light of recent events and the resulting heightened security at major airports, this will only get worse. This paper examines a proposal to make airport security more accessible to the Deaf community by using a translation and display system for American Sign Language (ASL). This proposal calls for computers equipped with ASL generation software and high resolution monitors to be placed at four strategic locations within the security checkpoint. These monitors will then display 3D computer animations depicting ASL translations of the English that the security guards are using.

KEYWORDS
Deaf, ASL translation, airport security

INTRODUCTION

Airport security is one of many public systems that are critically important but only barely accessible to the Deaf community. Despite laws such as the Americans with Disabilities Act (ADA) [1] and the Air Carriers Access Act (ACAA) [2], airports pose major problems for the Deaf. In addition to lacking access to spoken language, the Deaf must face the lack of visual counterparts to audio cues that alert hearing people to the fact that a security guard wants their attention. In particular, when a security guard gives a directive but does not receive the expected response, the potential for escalation to an adversarial situation is very great.

There has been partial success in using text to increase accessibility for the Deaf. Solutions have involved means such as simple written announcements, or blank pads of paper for written messages exchanged between deaf and hearing people, as well as the well known Telecommunications Device for the Deaf (TDD) and mechanical teleprinters (TTY)). However, all these approaches assume that the Deaf are fluent in English.

While ASL shares some vocabulary with English, there is no simple word-for-word translation, and in the Deaf community, fluency in English is not generally very high. In fact, the average reading level of Deaf adults in the United States is between the third and fourth grade level [3]. ASL is a natural language in its own right, and not simply a signed form of English. Research in linguistics has shown that its concise and efficient syntax differs radically from English grammar [4][5]. Although ASL is the third most commonly used language in the United States [6] its knowledge outside the Deaf community is rare[7]. Having a full-time human interpreter on hand at an airport would not be feasible due to the high cost involved. For these reasons, providing translations from English to ASL via 3D computer animations will greatly facilitate Deaf access to airport security procedures.

There are two ways to respond to this need. The first is to require Deaf passengers to carry their own personal translators, such as the iCommunicator [8]. The iCommunicator is a personal portable device developed by Interactive Solutions, Inc. However, it suffers from problems of its own. It does not show actual American Sign Language but shows a word-for-word translation from English. One common complaint is that it doesn't match text and real-time sign language very well, and lacks correct English modeling. Other disadvantages are its size and weight (up to 25 pounds), greatly hindering its portability, especially for air travelers. Finally, the prohibitive cost of this device (upward of $8,000 for a complete system) makes it inaccessible for the majority of Deaf individuals.

Since the iCommunicator is designed for general-purpose conversational speech and requires training with each individual speaker, it is prone to inaccuracies when a new person speaks into it. This is typical for the performance of current general speech-recognition systems, but in the context of airport security, such inaccuracies could have disastrous consequences. Finally the iCommunicator cannot be used when it is passing through airport x-ray machines, making it even less appropriate for security screening situations.

A better method places the responsibility for access on the airport. This is the system that we propose. Our system provides translations of a small, extremely structured set of dialogs, which makes it more robust. The cost is roughly

comparable to that of the single personal system currently available and becomes marginal when compared to the total operating cost of the facility.

SYSTEM DESCRIPTION

Our system uses a combination of software and hardware to provide Deaf access to airport security. The hardware consists of computers and monitors placed at strategic locations in the security screening process to provide displays of ASL animations.

Placing monitors in the person's line of vision will replace the audio cues for attracting attention. To check that the monitors are properly located in the passenger's field of view, requires walkthroughs of the setup, using virtual passengers of varying heights.

The software consists of two major components: translation software and display software.

Translation Software

The translation software has two subcomponents: voice recognition and machine translation. While there are both commercial and research systems to perform generalized voice recognition and machine translation, we use *a priori* knowledge of airport security to simplify the process.

Our system makes use of "word-skimming" to recognize and respond to keywords that a security guard is likely to say in any given situation. With this method, we selectively process relevant words while ignoring surrounding text that is too general and thus irrelevant to the domain. While the exchange between security guards and passengers is not scripted, there is a large degree of consistency in the dialog, and many of the phrases employed contain similar word phrases. Due to the small number of vocabulary words, the system needs significantly less training to be voice specific.

Word skimming has had success in various applications using speech recognition, such as interactive voice response (IVR), automated directory inquiries, call routing, and phone command and control systems [9]. Commercially produced and used trademarks include Atlantic IVR [10], FlexSpeech [11], InfoTalk [12], iVoice [13], and SpeechWorks [14].

Once the guard has started speaking, the machine translation system converts the message from English to American Sign Language. Machine translation is a rich topic of research, with both statistical [15] and tree-based [16] approaches providing solid results for general translation. However, statistical approaches require large corpora of previously translated text, while tree-based approaches require modeling semantic structures. Given the lack of translated documents and semantic models for ASL and the highly structured nature of the dialog in this application, we chose a more simplistic approach using a state machine, a thesaurus, and a database look-up. Airport security procedures are, in general, consistent enough that this approach suffices.

Display Software

The display portion of our system is a database-driven graphic package generating ASL phrases using a human model [17][18][19][20]. The database contains information about the model's hand shapes, hand locations and timing, as well as facial information and other non-manual sign components. The graphics engine we use is a widely available commercial product. Our human digital model, shown in Figure 1, is used to generate ASL animations in a natural and recognizable way.

FIGURE 1: Human Model for Displaying ASL

SYSTEM CONFIGURATION

The system configuration provides translation at critical points in the security screening process. The first translation component is used for initial screening; the second occurs prior to the metal detector and carry-on X-ray. The third handles the case when the alarm sounds on the metal detector or when a passenger is selected for additional personal screening. The fourth occurs when passengers pick up their carry-on items. This process is based on experience with 15 domestic airports, but could be changed to accommodate variations in procedure at individual airports.

Overview

The initial screening station is the location where security procedures start. Here, the passenger is asked to display identification and ticket. The next step is passing through the metal detector gate. There are several possible scenarios that can occur at this stage. If the metal detector doesn't sound, the passenger is instructed to proceed unless selected at random for further screening. If the metal detector beeps, a guard instructs the passenger to remove any metal items and to go through the detector again. If the metal detector beeps a second time or if the passenger has been randomly selected, a security guard will use a hand held metal detector (wand). At this point, security personnel may request to search carry-on items. Once this is complete, passengers are free to take their carry-on items, and proceed to their boarding gate.

Initial Screening

When passengers approach the security checkpoint, they are asked for ticket and identification (ID) and are warned that only ticketed passengers are allowed beyond the screening checkpoint. This is the location of the first monitor. See Table 1 for the English instructions and ASL translations.

Table 1 is divided into two parts: static instructions and dynamic translations. Static instructions are analogous to written instructions that are posted as a sign on a wall or other surface. In the proposed system, static instructions play repeatedly in a loop and are interrupted when a security guard speaks. The portion of the table pertaining to static instructions gives the English directive and the corresponding phrase in ASL, written in Baker-Cokely notation. In this notation, an asterisk indicates emphasis and a pound sign indicates a fingerspelled word. Each gloss, which corresponds roughly to an English word, appears in upper case. Yes/no interrogatives are marked with a superscript 'q' and a line above the word.

The second part of the table lists dynamic translations. In contrast to static instructions, dynamic translations are the phrases that must be displayed to depict a security guard's utterance. This part of the table has three columns. The first contains the directions uttered by the security guard. Due to space considerations, only the most representative variations appear. The second column lists the keywords used by the word skimmer to trigger the corresponding directive in ASL. The last column shows the ASL phrase in Baker-Cokely notation. All of the ASL translations were created after extensive consultation with members of the Deaf community.

A representation of the graphic display corresponding to one of the phrases in the table is shown in Figure 2. The English phrase most directly corresponding to the ASL is "ID and ticket, please".

Static Instructions (Played as loop)

English	ASL
Only ticketed passengers are allowed beyond this point.	TICKET MUST HAVE CAN ENTER

Dynamic Translations

English	Keywords	ASL
Can I see your ID and ticket? Show me your ID and ticket.	(Ticket, ID, License, Passport)	*SEE #ID TICKET #ID TICKET *you*-GIVE-*me*

TABLE 1: Instructions for Initial Security Screening.

Metal Detector

As the passenger approaches the site where the metal detector and X-ray machine are located, s/he will encounter the second monitor that displays further instructions. Passengers are directed to place all carry-on items on the conveyor belt. Computers are to be removed from their carrying cases and laid on the belt separately. Passengers are also directed to empty pockets of any metal items and to wait for an indication from a security guard to walk through the metal detector. Table 2 illustrates the vocabulary used in this process.
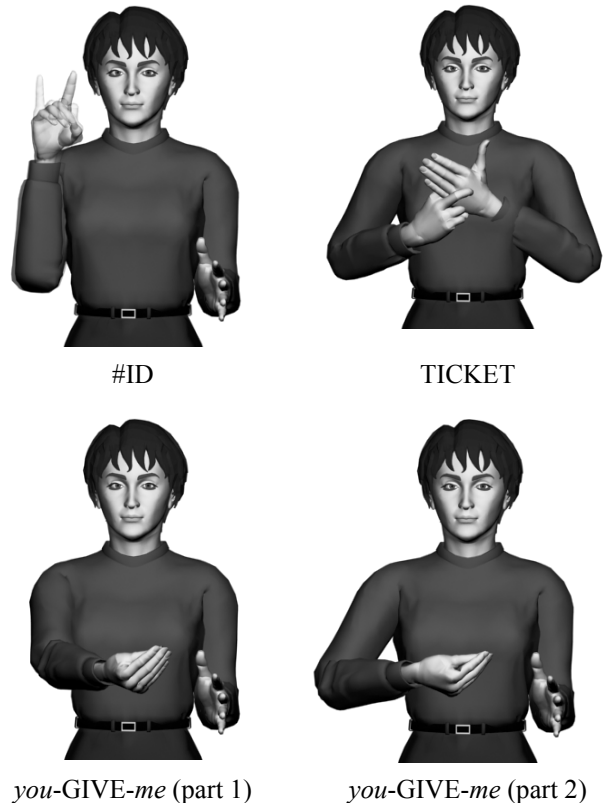

#ID   TICKET

you-GIVE-*me* (part 1)   *you*-GIVE-*me* (part 2)

Static Instructions (Played as loop)	
English	**ASL**
Please remove your computer from its bag and place it on the belt separately.	*IF HAVE COMPUTER OUT BAG *bag*-PUT-*machine* MACHINE
Place your carry-on on the conveyor belt	BAG MACHINE CONVEYOR
Put any metal, keys or coins in the tray.	HAVE COINS KEYS <u>ANY METAL</u>q BASKET *rt*-PUT-*basket*
Wait for guard	WAIT FOR GUARD

TABLE 2: Instructions for Metal Detector and Carry-on X-Ray

Metal Detector Alarm

After the passenger has passed through the metal detector, there will be a third monitor to provide further instructions. The default, assuming that no metal was detected, is a loop indicating that the passenger should pick up carry-on items and proceed to the gate. If the alarm sounds, the monitor immediately displays an ASL sign for "stop". See Figure 3. While there are other ASL signs for this word, this one is the most universally understood. The monitor will also flash as the sign is displayed. At this point the guard may ask the passenger to remove any remaining metal, and step back through the detector. The relevant vocabulary for this step is listed in Table 3, and frames from one of the animations are displayed in Figure 4.


STOP

FIGURE 3: An ASL Sign for STOP.

Dynamic Translations

English	Keywords	ASL
OK	OK	BAG PICK-UP
<beep detected>		STOP BACK
Put any metal in the tray.	(Metal, Keys, Belt, Coins, Pockets)	HAVE COINS KEYS
Empty your pockets.		<u>ANY METAL</u>q BASKET *rt*-PUT-*basket*
Step back through.	(Back, Through)	BACK
Go back through.		
Walk through again	(Through)	PROCEED

TABLE 3: Interactions After Alarm Sounds on Metal Detector.

HAVE

METAL

<u>_____</u>q
KEYS

BASKET
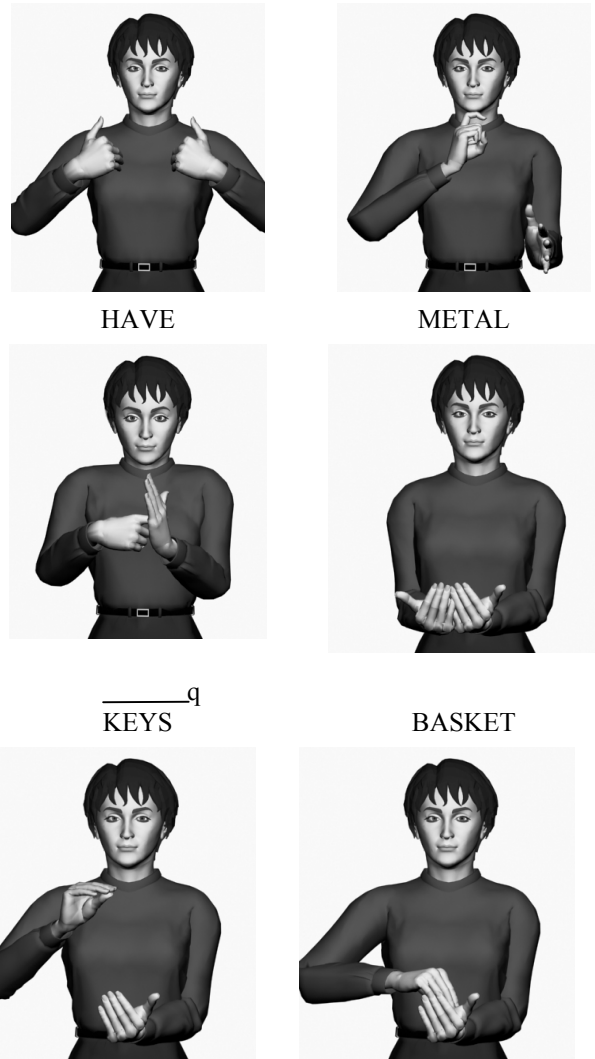
rt-PUT-*basket*   *rt*-PUT-*basket*

(part 1)   (part 2)

FIGURE 4: Frames from ASL Translation of "Put any metal objects in the tray."

Request to Search
When passing through the metal detector for the second time, if the passenger does not activate the alarm, the display monitor will instruct the passenger to pick up any carry-on items. If the metal detector alarm goes off a second time, the monitor will display instructions to follow the guard. See Table 4.

Dynamic Translations		
English	**Keywords**	**ASL**
OK	OK	BAG PICK-UP
Step aside	(Step, Come)	FOLLOW ME
Step over to the side		
Step this way		
Come with me		
Come here		
Come this way		

TABLE 4: Request to Search

Wanding

The guard will conduct a search using a hand held metal detector (wand). The interaction here is normally straightforward and involves asking the passenger to raise his or her arms followed by an indication that the wanding is complete. The relevant phrases and keywords are shown in Table 5.

Dynamic Translations		
English	**Keywords**	**ASL**
Raise your arms.	(Raise)	(Display shows gesture to emulate.)
You're finished / I'm done	(Finished, OK, Done)	FINISH. BAG PICK-UP.

TABLE 5: Wanding

Search of Carry-on Items

Once the passenger proceeds to luggage pick-up at the end of the conveyor belt, a final monitor will handle the instructions for a potential search or scan of the passenger's carry-on luggage. Certain key situations occur regularly, such as dealing with electronic devices, or finding items that must be removed from the carry-on, and asking the passenger not to touch any luggage while the search is conducted. The possible terms used are displayed in Table 6 and example frames from an animation in Figure 5.

Dynamic Translations		
English	**Keywords**	**ASL**
Please turn on your computer.	(Turn on)	COMPUTER TURN ON
Is this your bag?	(Your, yours)	_____ q YOUR BAG
May I search your bag?	(Search)	INSPECT BAG NOW
Please, don't touch the bag.	(Touch)	NO TOUCH BAG
<Item> cannot go onboard.	(pocket-knife, nail-file)	KNIFE, NAIL-FILE ILLEGAL
Have a good flight.	(Flight, OK)	HAVE NICE SAFE FLIGHT

TABLE 6: Search of Carry-on Items

KNIFE (part 1)   KNIFE (part 2)

ILLEGAL (part 1)   ILLEGAL (part 2)

FIGURE 5: ASL Translation for "Knives cannot go onboard."

RESULTS AND CONCLUSIONS

At the conference, we will demonstrate the feasibility of the system we have described. We have been working with the Deaf community, machine translation experts, and researchers in voice recognition to produce this system. The display aspect of the translation has been extensively user tested and consistently shows high rates of comprehension by native ASL signers, especially after significant improvements of the model's articulated hand and general physical appearance.

FUTURE WORK

The most difficult problem that our system will face is the extremely high levels of background noise found in even moderately busy airports. Although there are techniques for handling voice recognition in noisy environments, the simple expedient of having the security guard wear a microphone will allow us to use basic voice recognition software. We need to find out if security personnel are willing to do this.

There are many parts of this work that can be beneficially explored in the future. The actual security environment at most airports is much more fluid than the one described and must respond to unanticipated events. A fuller semantic modeling would allow us to use a tree-based approach to translation and thus allow a more general system. The use of generalized voice recognition systems that are user-independent would allow for a much greater range of inputs into the translation device and greater flexibility in personnel assignments. Finally, the number of airport sites using the system can be expanded to include ticket counters, gate counters and security stops prior to entering the airplane.

ACKNOWLEDGMENTS

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