Towards Accessible Conversations in a Mobile Context for People who are Deaf or Hard of Hearing

Dhruv Jain, Rachel Franz, Leah Findlater, Jackson Cannon, Raja Kushalnagar, and Jon Froehlich
University of Washington, Seattle
Gallaudet University
Prior work have investigated communication challenges of DHH people in **stationary contexts** such as group meetings and lectures.
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Moving conversations (e.g., walking) could present **new challenges** such as varying background noise and **needing to balance visual attention** between looking at the speakers and looking ahead.
Moreover, assistive technologies like real-time captioning have been traditionally designed for stationary context and are not conducive to mobile scenarios.
AIMS
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1. To investigate the needs of DHH people in mobile conversations such as walking and transit.
**AIMS**

1. To investigate the **needs of DHH people in mobile conversations** such as walking and transit.

2. To study the possibility of **captions on head mounted displays (HMDs)** to support those needs.
THIS PAPER
1. **Study 1**: Formative interview with 12 DHH participants on challenges, communication strategies, and future captioning technology.
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2. **Study 2**: Evaluation of a proof-of-concept HMD-captioning prototype with 10 DHH participants in a walking scenario.
Outline

Background and Past Work
Outline

Background and Past Work → Study 1: Interview
Background and Past Work → Study 1: Interview → Proof-of-Concept HMD Prototype
Outline

Background and Past Work → Study 1: Interview → Proof-of-Concept HMD Prototype → Study 2: Evaluation
Background and Past Work

→ Study 1: Interview

→ Proof-of-Concept HMD Prototype

→ Study 2: Evaluation
Captions can be generated in two ways:
AUTOMATIC SPEECH RECOGNITION (ASR)
We used a trained transcriber (or real-time captioning).
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Captions from a trained transcriber are typically shown on a laptop or a large shared screen.
Thus, researchers have explored mobile and wearable solutions.
Matthews et al., UbiComp 2006

(1) user needs sound info & clicks “what happened?” button

(2) the past 30 seconds of audio is sent to translator

(3) translator translates audio & sends to user in a text message

(4) user gets text message describing sound

New Text Message

“(digital female voice) Move your items to the bag please. Thank you for shopping at Safeway. Please remember to get your receipt.”

From: Study

Reply Call Delete Close
Though portable, smartphone apps require that users turn their gaze away from the speaker or environment.
To reduce this visual split, researchers have used HMD to show captions.
However, no work has evaluated HMD-based captioning in a mobile context.
Background and Past Work → Study 1: Interview → Proof-of-Concept HMD Prototype → Study 2: Evaluation
Study 1
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Goal

- To assess the communication needs and potential technologies for DHH people in mobile contexts.
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Participants
- 12 DHH individuals (5 males, 6 females, 1 did not disclose)
- Recruited through email, social media and snowball sampling
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Study Method
- Two part semi-structured formative interview in lab-setting: (i) challenges in a mobile conversation, (ii) ideas for future captioning technology
- Three mobile scenarios were explicitly explored: walking, in transit, and recreational.
Background and Past Work → Study 1: Interview → Proof-of-Concept HMD Prototype → Study 2: Evaluation
Background and Past Work

PART 1: Mobile conversation challenges

Study 1: Interview

Proof-of-Concept HMD Prototype

Study 2: Evaluation
Background and Past Work

Study 1: Interview

Proof-of-Concept HMD Prototype

Study 2: Evaluation

**PART 1:** Mobile conversation challenges

**PART 2:** Captioning technology design
Background and Past Work

Study 1: Interview

Proof-of-Concept HMD Prototype

Study 2: Evaluation

PART 1:
Mobile conversation challenges
Participants had mobile conversations while walking to or from meetings, classes, and social activities as well as on public transport and in cars.
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Assistive technology use in mobile contexts is rare.
“I don't usually use technology other than hearing aids in moving conversations. I will occasionally use my phone to type something if it’s impossible to hear. The [phone] isn't perfect because it demands that I split my attention and [also] have one [hand] holding the phone.”

- P12
MOVING CONVERSATION CHALLENGES
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• Conversations are brief and shallow
Moving Conversation Challenges

- Conversations are **brief and shallow**
- **Hearing people** do not understand and accommodate needs
"If I need to look away for some reason, a deaf person will automatically stop talking and resume when I’m ready. A spoken conversation doesn’t have that type of natural stop and start..."
Moving Conversation Challenges

- Conversations are **brief and shallow**
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- Conversations are **brief and shallow**
- **Hearing people** do not understand and accommodate needs
- **Recreational activities** are particularly challenging
“[In] martial arts: you have an instructor showing how to move the arms, hands, body, etc. while talking to describe it. Well if they have to “talk” by signing, then how the hell do they also show you how to hold your arms in the proper position?”
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Moving Conversation Challenges

• Conversations are **brief and shallow**
• **Hearing people** do not understand and accommodate needs
• **Recreational activities** are particularly challenging
• Challenges of varying **space, lighting** and **background noise**
Background and Past Work

PART 1:
Characteristics and Challenges

Study 1: Interview

Proof-of-Concept HMD Prototype

Study 2: Evaluation
Background and Past Work

Study 1: Interview

Proof-of-Concept HMD Prototype

Study 2: Evaluation

PART 1: Characteristics and Challenges

PART 2: Captioning Technology Design
All participants said they would use real-time captioning in at least one moving conversation scenario (walking, transit or recreational activity).
All participants said they would use real-time captioning in at least one moving conversation scenario (walking, transit or recreational activity). However, some were concerned that captions may affect conversation quality ($N=7$).
"I always prefer direct communication with hearing people. If technology or interpreters are involved, there is always a distance between me and the other person. It diminishes the quality of the human connection."

- P11
COMPARING DEVICES

SMARTPHONE

SMARTWATCH

HMD

STUDY 1 PART 2: TECHNOLOGY
<table>
<thead>
<tr>
<th>Activity</th>
<th>HMD</th>
<th>Smartphone</th>
<th>Smartwatch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walking</td>
<td>N=11</td>
<td>N=1</td>
<td></td>
</tr>
<tr>
<td>Transit (bus, car)</td>
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HMD was most preferred because it would reduce the visual attention split.
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For high-contact sports, some people wanted smartphone because **HMD could fall off**.
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Smartwatch was the least preferred because of the **small display size**.
DESIGNS SKETCHED BY PARTICIPANTS
P5: Integrate captioning with car GPS
To reduce having to look at multiple devices
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To reduce having to look at multiple devices

P2: A wrist worn device
To display captions
Background and Past Work → Study 1: Interview → Proof-of-Concept HMD Prototype → Study 2: Evaluation
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“This is third floor of the building. We have a shop here...”
“This is third floor of the building. We have a shop here. Below, there’s a restroom.”
"This is third floor of the building. We have a shop here."
"This is third floor of the building. We have a shop here."
Design 1: Captions at a fixed distance from the eyes

>> John: Yes, the weather here is quite nice today.

Design 2: Captions projected onto a surface

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- To assess whether the use of HMD captions increased conversation accessibility, and decreased attention split for walking conversations
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**Part 1: Walking Scenario with HMD**
- One researcher conversed with the participant on casual topics
- Another researcher took observational notes
- The first researcher wore a lapel microphone that relayed speech to the on-site transcriber

**Part 2: Open-ended Interview**
- On the experience any feedback to the prototype
All participants used our prototype to understand at least some part of the conversation while walking.
“With this, you can look where you want and still follow along with the conversation.”

- R4
However, four participants found captions to be occasionally distracting.
When I was trying to formulate my own responses, I would find the captions quite distracting and, in cases like that, I wish [...] that I could look away from [the captions], at my discretion.

- R5
High-Level Themes
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Visual Split

- Participants used both speechreading and captions.
- Oral speakers looked at speakers more than captions. Sign language users focused on captions more.
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Caption Placement
- Split between whether to show captions in the field of view (N=6) or above speakers (N=4).
- All wanted the ability to turn off the captions when needed.
High-Level Themes

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**Caption Placement**
- Split between whether to show captions in the field of view ($N=6$) or above speakers ($N=4$).
- All wanted the ability to turn off the captions when needed.

**Design Suggestions**
- Display speaker identification cues (e.g., name, location).
- Display environmental sounds (e.g., door opening).
- Display voice tone and volume.
Reflection
As the **first work** to explore communication challenges and technology design for DHH people in mobile context, we have shown that:
Mobile context offer **new challenges** and a **new unexplored space** for innovation.
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Assistive technology in mobile contexts need to be carefully designed.
DESIGN GUIDELINES for HMD-Captioning
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Automatic depth alignment
DESIGN GUIDELINES for HMD-Captioning

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Adapt to changing context
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Automatic depth alignment
Adapt to changing context
Convey contextual information
DESIGN GUIDELINES for HMD-Captioning

Automatic depth alignment
Adapt to changing context
Convey contextual information
Customizable
THE TEAM

Dhruv Jain
PhD Student, CSE, UW
djain@uw.edu

Rachel Franz
PhD Student, HCDE, UW
franzrac@uw.edu

Leah Findlater
Assist. Prof., HCDE, UW
leahkf@uw.edu

Jackson Cannon
UG Student, CSE, UW
jackscan@uw.edu

Raja Kushalnagar
Prof., Gallaudet University
raja.kushalnagar@gallaudet.edu

Jon Froehlich
Assoc. Prof., CSE, UW
jonf@uw.edu
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The Team

Dhruv Jain
PhD Student, CSE, UW
djain@uw.edu

Rachel Franz
PhD Student, HCDE, UW
franzrac@uw.edu

Leah Findlater
Assist. Prof., HCDE, UW
leahkf@uw.edu

Jackson Cannon
UG Student, CSE, UW
jackscan@uw.edu

Raja Kushalnagar
Prof., Gallaudet University
raja.kushalnagar@gallaudet.edu

Jon Froehlich
Assoc. Prof., CSE, UW
jof@uw.edu

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