FaceSpeaker
wearable face recognition device for the blind

Extended Abstract for the ICCHP 2014 young researcher consortium

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Abstract
FaceSpeaker is a prototype wearable face recognition device which supports visually impaired users during social interactions by covertly identifying their acquaintances. The prototype is based on a laptop worn in a backpack, running the open source FaceSpeaker software. The user controls the prototype using a small Bluetooth keyboard. The user wears camera glasses, and the FaceSpeaker software speaks an enrolled person's name when his face comes in view of the camera.

Introduction

Face recognition is the primary means by which humans identify each other. Visually impaired people cannot perceive faces, which means they are unable to rapidly identify people around them. This puts them at a major disadvantage in social interactions.

The FaceSpeaker project aims to design a wearable face recognition device which supports visually impaired users during social interactions by covertly identifying their acquaintances.

Although this is a technical challenge, all the necessary technology to build such a device is available as of 2013. The main challenge lies in designing a device which is socially acceptable to the user and people around him.

In this extended abstract we provide an overview of related work and we describe the FaceSpeaker prototype. We describe the study's methods and research questions, and give an overview of the study's results. We conclude by discussing this study's contribution to the field and directions for future research. The full project report, a video demonstration and the FaceSpeaker software can be found at the FaceSpeaker project website (facespeaker.org).

Background

We identified three related research efforts. A team at Arizona State University developed the iCare social interaction assistant. Their starting point was a face recognition device similar to the FaceSpeaker prototype. They expanded this prototype with various functions including person localization using a haptic belt and detection of socially disruptive stereotypic body mannerisms. Their work is summarized in a paper presented at ICCHP (Krishna & Panchanathan, 2010).

A student team at the University of Maryland developed a prototype similar to FaceSpeaker. The device could identify acquaintances, but the focus of their research was on facial expression recognition (Astler et al., 2011). A team from Osaka Prefecture University (Japan) published a paper proposing a covert wearable face recognition device to support human memory (Utsumi et al., 2013). They identified high level requirements for such a device and studied the socially acceptable time limit for identifying people.

The FaceSpeaker prototype design was influenced by Peter Meijer's "the vOICe" sensory substitution system (seeingwithsound.com). Another influence was the emergence of "augmented reality" glasses, such as Google Glass.

In June 2013 the Israeli company Orcam released a computer vision device for the partially sighted which will feature face recognition (orcam.com).

Prototype description

The user wears camera glasses and a backpack. The backpack contains a laptop and the "camera box" which holds the hardware for powering the camera glasses and sending the video stream to the laptop. The user controls the laptop using a small Bluetooth keyboard. Audio is conveyed through bone conduction headphones which do not obstruct the ears.

The laptop runs the FaceSpeaker software. This software constantly monitors the video stream captured by the camera and reacts whenever a face comes in view. If the detected face is unknown, the program issues a single low pitched beep. If the face belongs to a person enrolled in the database, the software issues a high pitched beep and speaks the person's name about half a second later.

The user can enroll a person into the database by typing that person's name on the small Bluetooth keyboard, hitting enter and looking in the person's direction. The software then captures 20 training images and issues a click for every training image captured, which confirms the camera is pointed correctly.

Method and research questions

The FaceSpeaker project was an exploratory, qualitative design study which addresses the following research question:

Q1. Is a wearable face recognition device which unobtrusively identifies acquaintances to its user feasible, and what should be its design?

A working prototype was developed. This involved writing a face recognition program in Microsoft Visual C# using the EmguCV computer vision library (emgucv.com) and acquiring the necessary hardware. Research questions addressed during prototype development include:

Q2. Which face recognition library is suitable for the prototype, and how should it be configured?

Q3. What camera should be used, and how should it be mounted onto the user's body?
Q4. How can the software take advantage of a multithreaded environment while minimizing power consumption and heat production?

The visually impaired community was involved with the project through various channels, and the prototype was field tested at ICCHP Summer University 2013 in Karlsruhe (icchp-su.net). This resulted in a lot of user feedback and a better appreciation of the issues involved in designing this device.

User feedback and literature study served as input for a PACT (people, activities, contexts, technology) analysis(Benyon, Turner & Turner, 2005) and a scenario to illustrate how the device might be used in practice. The "small conference scenario" depicts a FaceSpeaker device supporting a blind user in the context of a small scientific conference. This scenario served to motivate and illustrate various design recommendations for future prototypes. Research questions addressed include:

Q5. What should be the procedure for enrolling new acquaintances?
Q6. How should the device be triggered to identify a person?
Q7. How should the device convey a person's identity to the user?
Q8. How much time is available for conveying a person's identity to the user?

Results

The study resulted in a working prototype based on open source software which can benefit future research efforts. We identified 2 overriding requirements the device should meet: 1) unobtrusiveness of the device and 2) economizing on the user's attention. We provided various design recommendations for future prototypes. Recommendations include:

1. An option for covertly enrolling acquaintances.
2. A "filtered automatic" approach to identifying people, in which the user has options to configure when the device reacts to a person coming in view of the camera.
3. The current prototype issues an auditory signal to announce an identification. This should be replaced by vibrotactile feedback.

Discussion

The open source face recognition software and documentation for the hardware prototype are available on the FaceSpeaker website and could benefit researchers developing similar prototypes. FaceSpeaker was an exploratory and somewhat informal study, so the resulting design recommendations are tentative and need to be validated by more systematic means. However, the design recommendations are valuable as a starting point for future research efforts. Many of the design recommendations are novel or challenge results from previous studies. The extensive motivation of design recommendations facilitates an informed discussion of the proposed design.

Next steps

Follow-up research should aim to refine and validate the proposed design. This will involve developing a more reliable prototype which incorporates the design recommendations provided by this study. This prototype could take advantage of better face recognition libraries and emerging technical trends such as augmented reality glasses and increasingly powerful mobile computing devices. Such a prototype would enable us to validate design recommendations by more systematic means. At this time we are exploring directions for follow-up research, and we are open to collaboration opportunities.

Relevance in ICCHP context

The FaceSpeaker study proposes an assistive device which enhances participation of the visually impaired by enabling them to be more effective in social interactions. This is exactly the sort of technology ICCHP focusses on. In addition, FaceSpeaker is directly related to research presented at ICCHP (Krishna & Panchanathan, 2010).

References

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