Wireless Headset Communications for Vision Impaired Persons in Multi-User Environments

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ABSTRACT
Wireless headsets are a great asset to Vision Impaired Persons (VIP's) as they prove to be much easier to use and reliable than wired equivalents. Radio based wireless headsets are the most common and have many favorable characteristics, however for environments where there may be numerous users with wireless headsets, radio channels easily become congested compromising audio quality and reliable operation. The research undertaken in this project attempts to sidestep the radio channel congestion problem and also produce a wireless headset tailored to the requirements of VIP's.

Categories and Subject Descriptors
H.5.1 [**Multimedia Information Systems**]:– audio Input/output, evaluation/methodology. K.4.2 [**Social Issues**]:- assistive technologies for persons with disabilities, handicapped persons/special needs.

General Terms
Design, Experimentation, Human Factors. Security

Keywords
Screen reading software, audio communication, wireless, headset

1. INTRODUCTION
A large proportion of VIP's disabilities seek employment in call centers where the effects of their disability are not a significant impediment. [1]. This project describes a system to assist call center workers by developing a high quality audio, dual channel wireless headset tailored for VIP's working in Multi-User Environments. The headset, not currently available commercially will also have application for persons not suffering visual disabilities, both in call centers and in the defense forces.

2. HEADSET REQUIREMENTS

To be suitable for VIP's working in multi-user environments the headset needed to be able to meet the following criteria.

2.1 High Quality Dual Channel Audio
The requirement for high quality audio stems from the use of screen reading software by VIP's for computer interaction. The screen reading software verbally communicates the computer information at an extremely high word rate, and thus to be intelligible, the audio needs to be high fidelity (in terms of quantization and frequency spectrum) and of low delay. Also if high quality audio communications are not used, the user can become easily 'hearing fatigued', a significant problem when employees may work a eight hour shift.

The dual channel audio requirement relates to the scenario that in call center applications VIP's receive voice output from screen reading software on one channel, and a telephone output for human interaction on the other. For user intelligibility the channels must be totally independent and devoid of inter-channel interference. A third channel from the headset to the base station must be incorporated for two way communication with the client caller.

2.2 Secure Communications
Call centre's often deal with sensitive information such as credit card number's, personal information etc and thus require communications to be secure from unauthorized interception. Current radio based headset designs are particularly vulnerable in this regard, where the radio waves can be easily intercepted outside the office environment. Encryption systems help provide some security for such uncontainable communications however even the latest standards can not be considered invulnerable.

2.3 Robust and Scalable Operation
For work environments the operation of the wireless headsets needs to be reliable and scalable. Currently most common radio based headsets use unlicensed radio spectrum where the operation of radio communications can not be guaranteed. General interference and competing users of the unlicensed spectrum in close vicinity easily compromise system performance.
Licensed spectrum, while being an ideal solution in theory can be expensive, and requires additional operational overhead to setup and maintain.

3. HEADSET DESIGN SOLUTION
To meet the stated requirements ultrasonic, magnetic and various electromagnetic mediums (e.g. radio, light) were considered. Many possible communication solutions are available, however the use of a granular, cellular architecture or line of sight (LOS) characteristic is fundamental in any case to ensure reliable, quality and secure operation for a wireless headset operated in multi-user environments.

Given this fundamental, further investigation found a dual combination of infrared (IR) frequency communications, which can be LOS and cellular, and radio communications provided the most appealing solution. In theory IR communications would

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deliver the high bandwidth audio bit stream with reliable and secure operation, whilst the radio medium would be called upon as required to allow user freedom of movement when LOS IR can not.

4. PROOF OF CONCEPT PROTOTYPE

Many radio based headsets are available for performance testing, however no dual channel, high quality audio IR headset is currently available commercially. Hence to prove the theoretical design, a prototype was developed so VIP's could test and document on the practical performance of IR communications in the real environment.

The developed prototype uses IrDA standard communications hardware, which is high bandwidth (~ 4Mbps), cheap and flexible, and a Digital Signal Processor (DSP) for control. A per user base station and headset cellular architecture is implemented (See Fig 1).

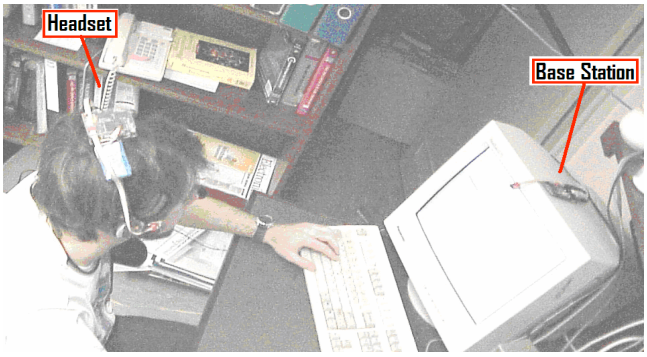

Figure 1: Wireless headset system in use.

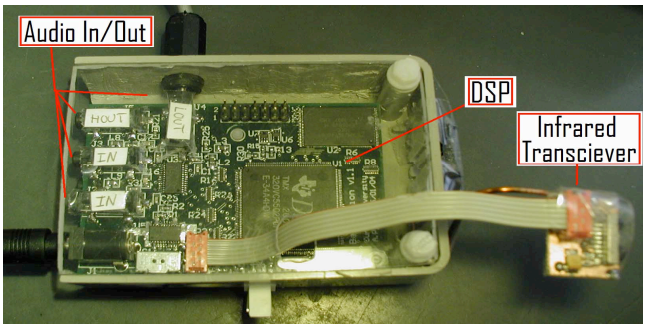

Figure 2: Wired Base Station

The wireless headset utilizes dual IR transceivers to improve the angular range of operation and user freedom of movement in IR LOS mode. These transceivers provide a typical range of up to 2m, and angle of operation combined of 120 degrees combined. This should be sufficient enough to ensure that for operation in front of a PC terminal the system will be using the backup radio communications for only a small fraction of the time.

The headset as a prototype has no radio communication functionality as operating characteristics are well know for a variety of standards (Bluetooth, 802.11 etc) and did not need to be tested. This functionality also is open to the radio standard most suitable for the situation (spectrum, range) and can be simply added or swapped through standard USB interfaces.

With IrDA protocol overhead, the basic design allows very high audio quality with bit streams up to 700Kbps per user. This compares well with the audio bit rate and system capacity of radio only based designs. [2]

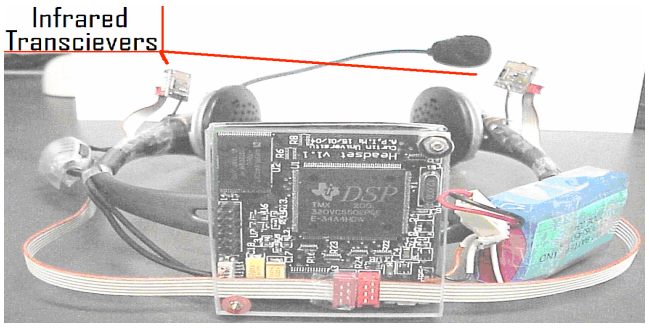

Figure 3: Wireless Headset

5. DESIGN TESTING

The headset operation was reliable and predictable. Interference from others users is easily controlled to ensure scalability demonstrating a very cellular and LOS system suitable for dense call centre environments.

While the IR communications are inherently secure and contained within the office environment (the carrier signal does not permeate walls), the audio communications can be intercepted through glass windows. However curtain blinds provide the same security to the audio communications as they do to visual privacy.

It was found that the high bit rate audio stream originally implemented at 368Kbps was still not sufficient enough for VIP's using high speech rate screen-reading software over extended periods of time. Fortunately due to the bandwidth headroom provided by the IR data link and the flexibility of the DSP based design, the system was easily modified.

Overall, the project demonstrates a system design that meets the criteria for a wireless headset tailored for VIP's in multi-user environments, and as such

6. FUTURE DEVELOPMENT

Further work is required to implement and test a combined infrared/radio system and the necessary seamless handover between infrared and whichever radio communication standard is used.

7. ACKNOWLEDGEMENTS

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