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open questions and explores the future of
Part I concerns the problem of enhancing
an array of microphones. For a variety of
computer interaction and hands-free telephony
roam unfettered in diverse environments
speech signal and robustness against background
and reverberation effects. The use of microphone
tunity to exploit the fact that the source of
noise sources are physically separated in space
ing techniques, typically developed for array
were initially applied to the hands-free system
the environment in which microphone arrays
from that of conventional array applications
has an extremely wide bandwidth relative to
that conventional narrowband techniques

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and track one or more speech sources is an essential requirement of microphone array systems. For speech enhancement applications, an accurate fix on the primary talker, as well as knowledge of any interfering talkers or coherent noise sources, is necessary to effectively steer the array, enhancing a given source while simultaneously attenuating those deemed undesirable. Location data may be used as a guide for discriminating individual speakers in a multi-source scenario. With this information available, it would then be possible to automatically focus upon and follow a given source on an extended basis. Of particular interest lately, is the application of the speaker location estimates for aiming a camera or series of cameras in a video-conferencing system. In this regard, the automated localization information eliminates the need for a human or number of human camera operators. Several existing commercial products apply microphone-array technology in small-room environments to steer a robotic camera and frame active talkers. Chapter 8 summarizes the various approaches which have been explored to accurately locate an individ-

beamforming methods to reduce background noise. These methods are shown to dramatically improve the speech quality and are compared and paired and to increase their overall satisfaction. This chapter focuses on the case of a simple two-element array and how to achieve noise and echo reduction. The chapter is analyzed under realistic acoustic conditions for desktop conferencing and intercom applications with the problem of acoustic feedback in mind. Various techniques involving loudspeakers and microphone arrays and cancellation methods are integrated within the chapter to enhance echo suppression. These results are applied to channel conferencing scenarios. Chapter 10 discusses microphone arrays for sound capture in automobiles. The chapter also discusses echo cancellation specifically within the context of a particularly effective approach is detailed.

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2.3.5 Design for Measured Noise Field

2.4 Extensions and Details

2.4.1 Alternative Form

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helped us in a big way. In the early days
nal processing complexity were possible.
high cost DSP computations, where com
widespread use of the technology. Today
us to implement all but the most comple
processing technology in real-time. But t
from breaking through the computing bo
problems at hand has significantly progres
of the results presented are from recent y
the potential and the limitations of micr
too often the same problems that were
years ago are still set apart for 'future
proposed solutions are similar to the ones
for a long time. Generally speaking we r
tions add to our understanding but lack r
future for themselves.

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