Echo Cancellation with hands-free cell phone

\*Note: Sub-titles are not captured in Xplore and should not be used

line 1: 1st Given Name Surname   
line 2: *dept. name of organization   
(of Affiliation)*  
line 3: *name of organization   
(of Affiliation)*line 4: City, Country  
line 5: email address or ORCID

line 1: 4th Given Name Surname  
line 2: *dept. name of organization*  
*(of Affiliation)*  
line 3: *name of organization   
(of Affiliation)*line 4: City, Country  
line 5: email address or ORCIDline 1: 2nd Given Name Surname  
line 2: *dept. name of organization   
(of Affiliation)*  
line 3: *name of organization   
(of Affiliation)*line 4: City, Country  
line 5: email address or ORCID

line 1: 5th Given Name Surname  
line 2: *dept. name of organization   
(of Affiliation)*  
line 3: *name of organization   
(of Affiliation)*line 4: City, Country  
line 5: email address or ORCIDline 1: 3rd Given Name Surname  
line 2: *dept. name of organization   
(of Affiliation)*  
line 3: *name of organization   
(of Affiliation)*line 4: City, Country  
line 5: email address or ORCID

line 1: 6th Given Name Surname  
line 2: *dept. name of organization   
(of Affiliation)*  
line 3: *name of organization   
(of Affiliation)*line 4: City, Country  
line 5: email address or ORCID

*Abstract*—In this paper different ways to execute echo cancellation were discussed. Echo cancellation can be achieved by an adaptative filter based on the system identification scheme. Some of the algorithms used in this paper were NLMS and Fast Block LMS. [title, text, heads, etc.] in its style sheet. *\*CRITICAL: Do Not Use Symbols, Special Characters, Footnotes, or Math in Paper Title or Abstract*. (*Abstract*)

Keywords—component, formatting, style, styling, insert (key words)

# Introduction to the problem

In general, noise can be a problem if it is mixed with any signal of interest. That problem shows up even more when a person is making an important call or meeting in a conference room, the voice of the person on the other side of the communication must be intelligible. The conditions of this problem vary a lot, due to the fact that not all conference rooms are equal, for example, the dimensions of the room and what the walls are made of are factors that change the impulse response.

The formatter will need to create these components, incorporating the applicable criteria that follow.

# determine the conditions of the problem

## Selecting a Conference room

The intention of this paper is to make an adaptative filter that works on at least 99% of the time, but the key question is how can someone guarantee that is going to work on most cases?

First of all, as we don’t own all conference rooms in the world, we have to generate a way to test our adaptative filter.

To generate a room impulse response the gpuRIR was used (<https://github.com/DavidDiazGuerra/gpuRIR>).

## Selecting the adaptative filter

To determine which adaptative filter is the best, we have to define our inputs and outputs. The signal we send is recorded by a microphone which has several acoustic paths and introduces the echo generated by the room and all kind of things inside it. The signal we receive is the voice of the other person we want to communicate with.

The sound is played by a speaker, which has some non-linearities and can contribute to the input of the microphone.

What we want intuitively is to filter the echoes inside the microphone in order to send my voice to the other person.

Up to now, we have two signals:

-Received signal (voice of the other person)

-Microphone recording

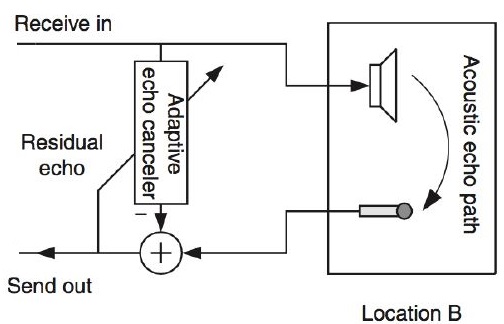
Of those signals we want to obtain our voice, and that is the component that is in microphone recording but not in received signal. We must remember that the microphone also receives the received signal as an input.

-Received signal: voice1

-Microphone recording: voice1+echoesofvoice1+voice2

If somehow, we got the part that has minimum correlation between Received signal and Microphone recording we would obtain voice2. That is assuming blablabla

This leads us to one of the classic adaptative filter schemes which is Adaptative Echo Cancellation.



## Selecting the algorithm to run tests.

As every audio subarray power changes along the complete array, the first naive test was with NLMS algorithm. The results were acceptable but took approximately X seconds to process X so in terms of computational complexity, it was not the best option.

As a result, we looked into another algorithm called Fast Block LMS, which processes the input by blocks and saves time according to the increment of the block length.

# Decision making: testbencheS

# Results and anaylisis

Before you begin to format your paper, first write and save the content as a separate text file. Complete all content and organizational editing before formatting. Please note sections A-D below for more information on proofreading, spelling and grammar.

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## Units

* Use either SI (MKS) or CGS as primary units. (SI units are encouraged.) English units may be used as secondary units (in parentheses). An exception would be the use of English units as identifiers in trade, such as “3.5-inch disk drive”.
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* Use a zero before decimal points: “0.25”, not “.25”. Use “cm3”, not “cc”. (*bullet list*)

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*a**b* 

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* The subscript for the permeability of vacuum **0, and other common scientific constants, is zero with subscript formatting, not a lowercase letter “o”.
* In American English, commas, semicolons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited, such as a title or full quotation. When quotation marks are used, instead of a bold or italic typeface, to highlight a word or phrase, punctuation should appear outside of the quotation marks. A parenthetical phrase or statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.)
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* There is no period after the “et” in the Latin abbreviation “et al.”.
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An excellent style manual for science writers is [7].

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1. Table Type Styles

| Table Head | Table Column Head | | |
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| Table column subhead | Subhead | Subhead |
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1. Sample of a Table footnote. (*Table footnote*)
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##### Acknowledgment *(Heading 5)*

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##### References

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1. G. Eason, B. Noble, and I. N. Sneddon, “On certain integrals of Lipschitz-Hankel type involving products of Bessel functions,” Phil. Trans. Roy. Soc. London, vol. A247, pp. 529–551, April 1955. *(references)*
2. J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68–73.
3. I. S. Jacobs and C. P. Bean, “Fine particles, thin films and exchange anisotropy,” in Magnetism, vol. III, G. T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271–350.
4. K. Elissa, “Title of paper if known,” unpublished.
5. R. Nicole, “Title of paper with only first word capitalized,” J. Name Stand. Abbrev., in press.
6. Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, “Electron spectroscopy studies on magneto-optical media and plastic substrate interface,” IEEE Transl. J. Magn. Japan, vol. 2, pp. 740–741, August 1987 [Digests 9th Annual Conf. Magnetics Japan, p. 301, 1982].
7. M. Young, The Technical Writer’s Handbook. Mill Valley, CA: University Science, 1989.

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