Digital Signal Processing Team - UFABC

Guilherme Seidyo Imai Aldeia

Universidade Federal do ABC

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Quem somos

Guilherme S. I. Aldeia
Bacharel em Ciência da Computação

Kaleb Alves
Engenharia de Informação

Guilherme Barreto
Engenharia de Instrumentação, Automação e Robótica

Alex E. Crispim
Bacharelado em Física

Henrique Ferreira
Bacharelado em Física

Kenji Nose-Filho
Doutorado em Engenharia Elétrica

Como surgimos

Em janeiro de 2019 nos juntamos para participar de uma competição internacional de processamento de sinais digitais. O resultado disso foi a criação de uma equipe chamada DSPTeam - UFABC.

2019 IEEE Signal Processing Cup:

Search and Rescue with Drone-Embedded Sound Source Localization

- Competition Details –

MathWorks®

IEEE Signal Processing Society®

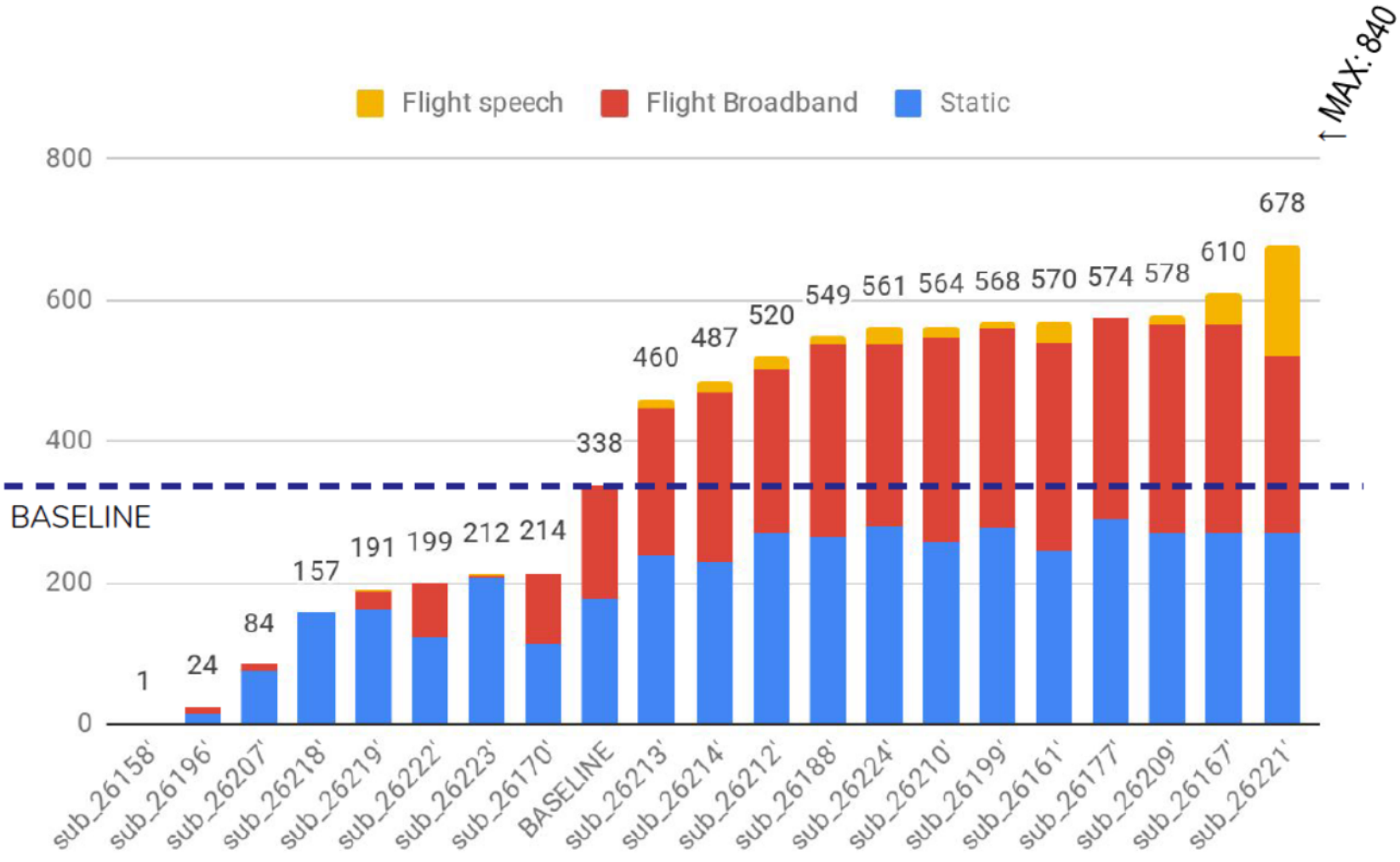
Signal Processing Cup 2019

O objetivo era processar sinais de 8 microfones acoplados em um drone para encontrar a localização de uma fonte sonora.

Motivação da competição

"Unmanned aerial vehicles (UAV), commonly referred to as drones, have been of increasing influence in recent years. Search and rescue scenario swhere humans in emergency situations need to be quickly found in areas difficult to access constitute an important field of application for this technology."

Nosso desempenho

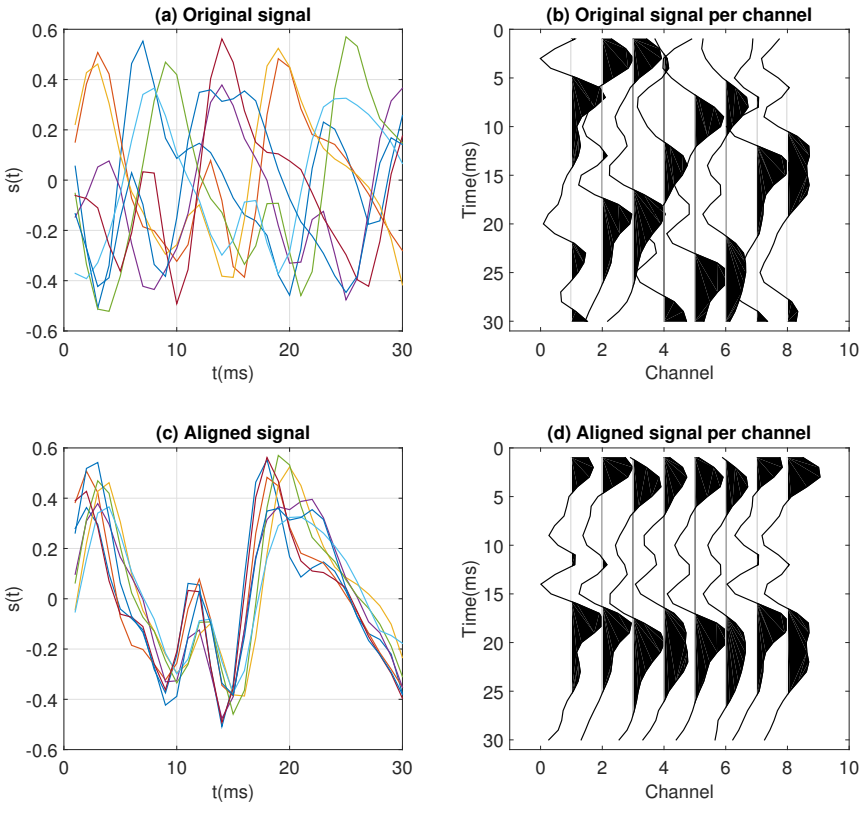


Nosso desempenho

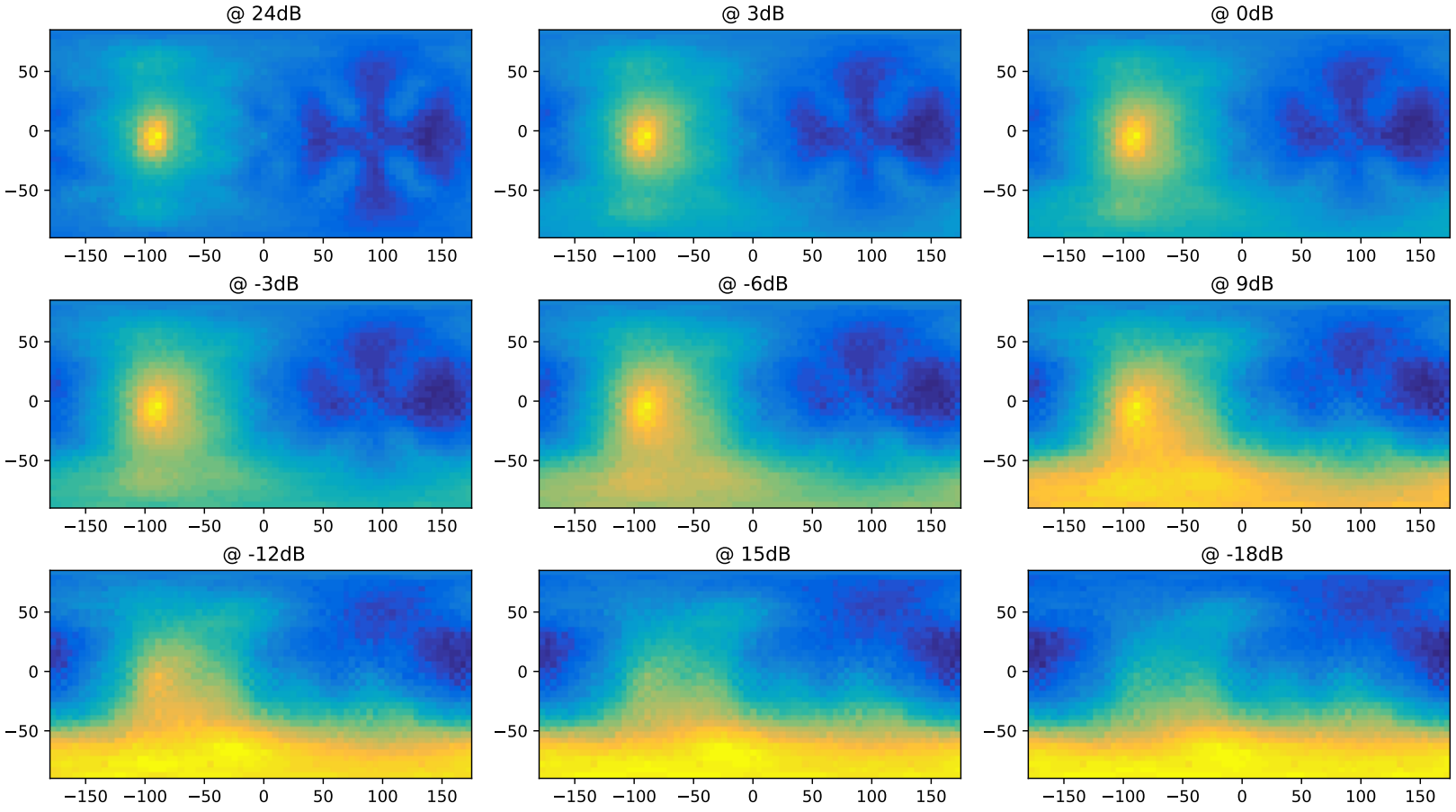
Nossa classificação foi baixa, e não poderemos mais participar da competição.
Entretanto, a equipe gostou do método desenvolvido, e desde então vem trabalhando para aperfeiçoá-lo.

Método baseado no Semblance

Criamos um método inspirado no processamento de sinais sísmicos, que funciona buscando alinhar os sinais de todos os microfones.



O drone agora pode "enxergar"



Escrevemos um artigo sobre o método

XXXVII SIMPÓSIO BRASILEIRO DE TELECOMUNICAÇÕES E PROCESSAMENTO DE SINAIS - SBrT2019, 29/09/2019–02/10/2019, PETRÓPOLIS, RJ

A semblance based TDOA algorithm for sound source localization

Guilherme Seidyo Imai Aldeia, Alex Enrique Crispim, Guilherme Barreto, Kaleb Alves, Henrique Ferreira, Kenji Nose-Filho

***Abstract*— In this paper we propose a new time difference delay of arrival technique based on the semblance multichannel coherency function for the problem of sound source localization. The proposed algorithm was tested on recordings from an Unmanned Aerial Vehicle (UAV) equipped with an array of 8 microphones, for estimating the azimuth and elevation angles of a speech based source. Our results shown that the semblance method has proven to be a robust strategy, obtaining good results regardless of the ego noise even in cases where the signal-to-noise ratio (SNR) was very low.**

***Keywords*— time difference of arrival, semblance, sound source localization**

II. A SEMBLANCE BASED TDOA ALGORITHM

In this paper, we want to find the direction of a sound source (azimuth, elevation) using the records from an 8-channel cube-shaped microphone array embedded in a flying UAV [7].

The proposed algorithm is based on correcting the time-delay that the propagating wave arrives in each of the 8-channel microphones. Given a source at direction $\mathbf{k_d} \in \mathcal{R}^3$, that point towards a source parametrized by azimuth $\Theta_d \in [-\pi, \pi]$ and elevation $\Phi_d \in \left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$. The time delay of a microphone at location $\mathbf{m_i}$ and a reference point at the origin

Escrevemos um artigo sobre o método

Semana passada recebemos a notícia de que o artigo foi aprovado!

Conference	Paper title (details)	Status
SBrT 2019	*A semblance based TDOA algorithm for sound source localization*	Accepted

SBrT 2019!


SBrT 2019
Artigos Aceitos
Inscrições
Programação Técnica
Local do Evento
Hospedagem
Contato
SBRT 2019
XXXVII Simpósio Brasileiro de Telecomunicações e Processamento de Sinais
Comunicação, Aprendizado e Cooperação entre Máquinas, Objetos e Humanos

SBrT 2019!

$$\Delta\sigma = \arctan \frac{\sqrt{(\cos\phi_2 \sin(\Delta\theta))^2 + (\cos\phi_1 \sin\phi_2 - \sin\phi_1 \cos\phi_2 \cos(\Delta\theta))^2}}{\sin\phi_1 \sin\phi_2 + \cos\phi_1 \cos\phi_2 \cos(\Delta\theta)}.$$

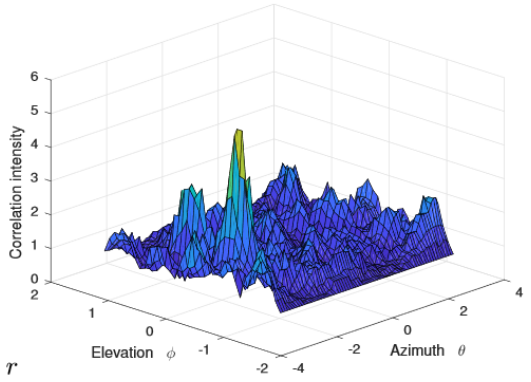
$$Z_d = \frac{\sum_n |\sum_i s_i(n)|^2}{N_r \sum_n \sum_i |s_i(n)|^2} \qquad 4\pi \sin^2(\theta/2) \approx \pi\theta^2 \approx 0.1 \text{ sr},$$

Algorithm 2: Find semblance local (find_local)

input : $frameSize$: size of the frames
$overlap$: overlap between frames
Δ: interval between angles to be tested
SoS: speed of sound on the medium
Fs: sampling rate
x: the data of the 8-channel
$micPos$: array with coordinates [x, y, z] of the microphones positions
output: z: matrix mapping correlation with angles
Θ: tested values for elevation
Φ: tested values for azimuth

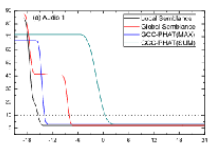
$sTotal = length(x);$ // total samples
$sSize = round(frameSize * Fs);$ // sample size
$sOverlap = round(overlap * sSize);$ // sample overlap
$nFrames =$
$ceil((sTotal - sSize)/(sSize - sOverlap)) + 1;$
$painels = [\ ];$
for *i in range(nFrames)* **do**
  $begFrame = i * (sSize - sOverlap);$
  $endFrame = begFrame + sSize;$
  $xFrame = x[begFrame : endFrame, :];$
  $painels[i] = find\_global(delta, SoS, Fs, xFrame);$

return $pooling(painels), \Theta, \Phi;$

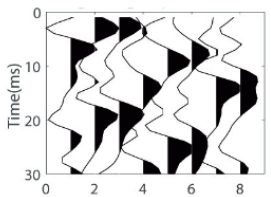


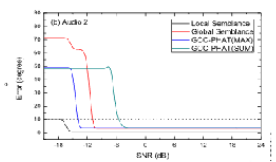
$$\frac{0.1 \cdot r^2}{r} = \frac{r}{10},$$

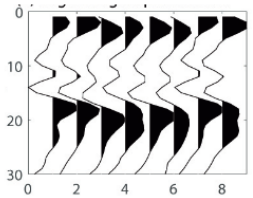
Fig. 1
3D SURFACE REPRESENTATION OF THE SEMBLANCE FUNCTION RESULT. THE HIGHER VALUES OF THE SIGNAL CORRELATION ARE REPRESENTED BY THE HIGHEST PEAKS.

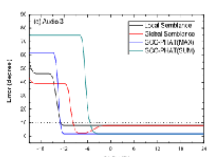


$$\tau(\mathbf{m_i}) = -\frac{\mathbf{k_d} \cdot \mathbf{m_i}}{v},$$









(*i*) overlap = [0, 0.1, 0.2, 0.3, 0.4, 0.5]
(*ii*) Δ = [17.5, 15, 12.5, 10, 7.5, 5]
(*iii*) frameSize = [0.064, 0.128, 0.256, 0.512, 1.024]