Assignment: Source Localization

For this homework assignment you will explore the topic of acoustic source localization.
The localization problem is described on the slides:
- DAAP-10_microphone_arrays_spatial_methods

You are provided with a multichannel recording $\mathbf{y}(n) \in \mathbb{R}^{M \times 1}$ acquired using a uniform linear microphone array (ULA). The device known as EStick, is composed of $M = 16$ MEMS microphones and it has a total length of $L = 45[\text{cm}]$. The ULA works with an Audio-over-IP connection recording at $Fs = 8[\text{kHz}]$. The acoustic scene recorded concerns a moving sound source in front of the ULA. The speed of sound has been measured as $c = 343[\text{ms}^{-1}]$.

Your task is to localize the time-varying position of the source using a spatial filtering approach. In particular, you are requested to design a delay-and-sum beamformer for the ULA and adapt it to localize wide-band sources. Remember that spatial filtering is a narrow-band technique, thus each frequency band is processed independently. Considering time-varying sources, a short-time processing is required performing the spatial filtering frame by frame. In addition, assuming that a single wide-band source is present, the localization can be achieved averaging the information across the frequency.

The script performing the localization must be implemented in Matlab. A modular approach is recommended, writing independent functions for code blocks such as DAS filter, and STFT processing. You are tasked to implement the short-time Fourier transform yourself.
Please provide and be ready to discuss the following:
- One figure showing the averaged pseudospectrum at different time instant (hint: use 2D plot with time on one axis)
- One figure depicting:
  - ULA setup displaying each sensor
  - Estimated DOAs depicted as arrows pointing in the direction of the source position (hint use the `quiver` function to draw the arrow)
- A video showing the arrows appearing for each time frame

Make sure to label the axes correctly, e.g., by expressing time in seconds, frequency in Hertz and directions in degrees. Please note that this homework assignment is designed for didactic purposes, so you should refrain from using built-in functions or library methods that carry out high-level operations e.g., `stft`.
- Please provide the **source codes** and explain the implementation details and results **in a report as a PDF file** which explains **how** the spatial filtering is implemented and your choices.
- Groups of **at most 2 people** are allowed.
- Each group should upload the code on WeBeep as a **single zip file.** One student will submit a zip file for the entire group; **do not upload the same HW twice.**
- The zip file should be named with the surnames of all group members, e.g., Mario Rossi and Maria Bianchi will upload a file named DAAP_HW1_Rossi_Bianchi.zip
- Upload the required file using the WeBeep platform in the delivery folder.