Supplemental Material for Paper 2523

Microphone Arrays as Generalized Cameras for Integrated Audio Visual Processing

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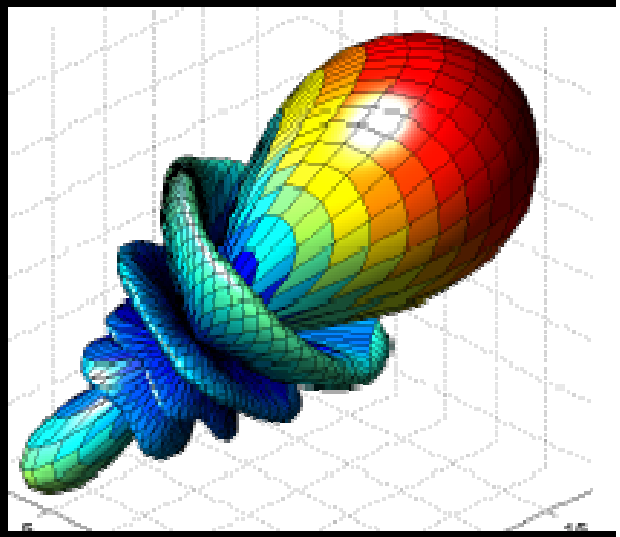
Spherical Microphone Arrays as Central Projection Sound Field Cameras

- Sound is collected at the microphones on a spherical array
- If we weigh the collected data appropriately and sum it, it is possible to pick out the sound from a particular direction, and suppress those from others.
- A direction on the sphere (a ray from the center along a particular direction) is characterized by a spherical delta function in two angles
- Using the spherical harmonic expansion for the delta function, truncating it to the order achievable by the array, we can collect sounds in ray-like beampatterns in any direction [see Refs. 20, 15]



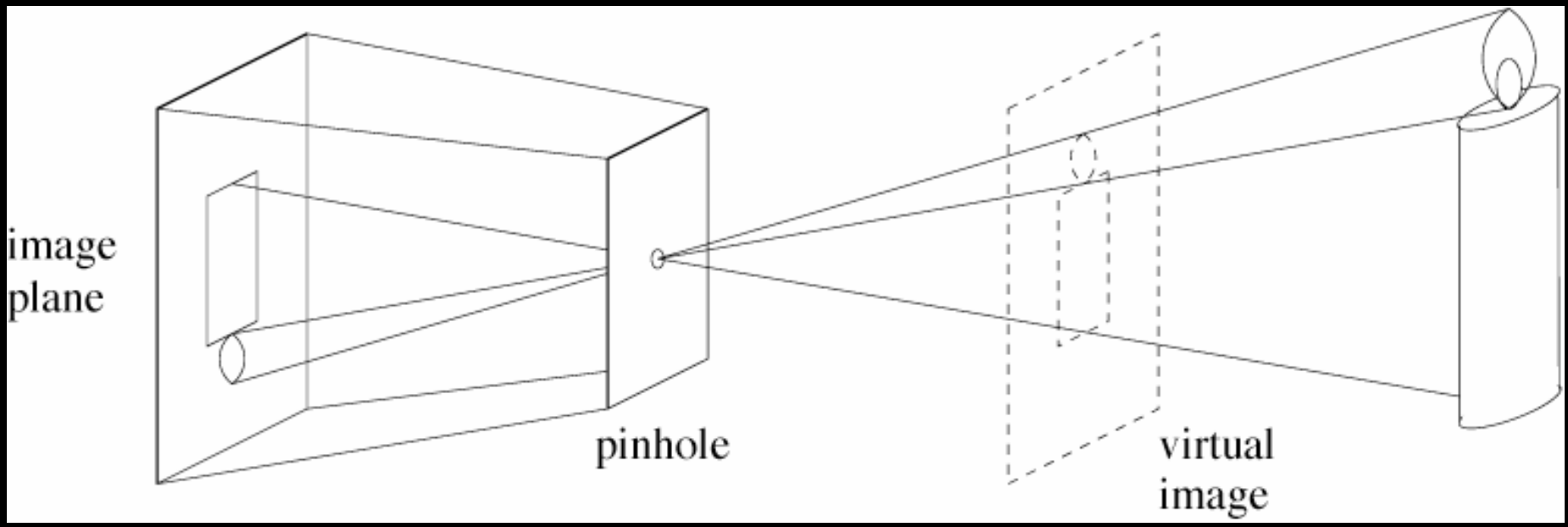
- The figure on the right shows an achieved spherical ray corresponding to a spherical harmonic expansion of order 6

Experimental spherical microphone array

- A 60 element spherical microphone array on a sphere of radius 0.09 m
- Beamweights computed according to References [20, 15]
- Note sound captured once can be processed either at the same time or later with different weights
- The beampattern is like the "point-spread function"

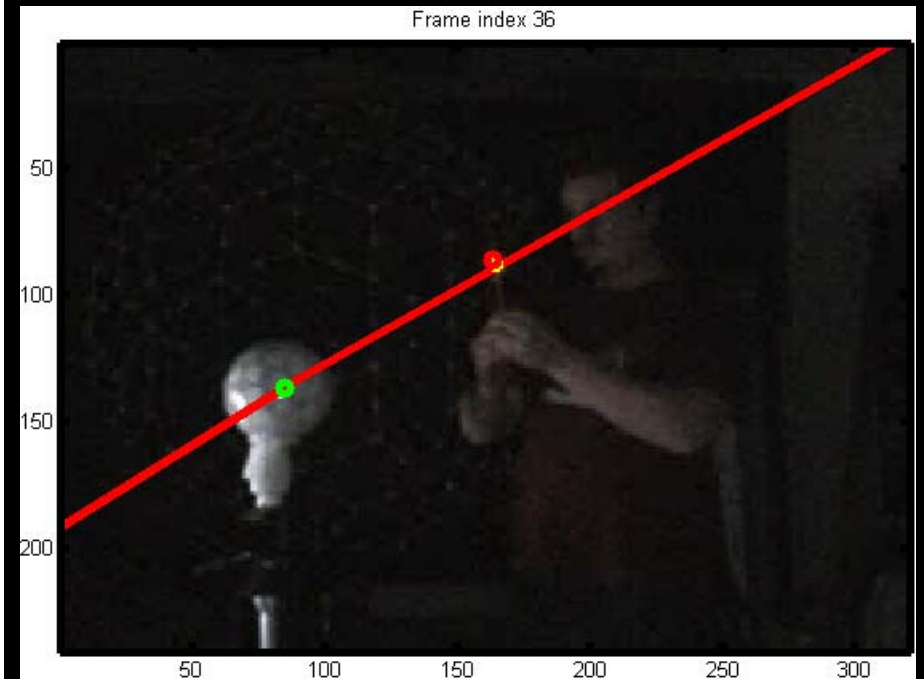
Central projection camera

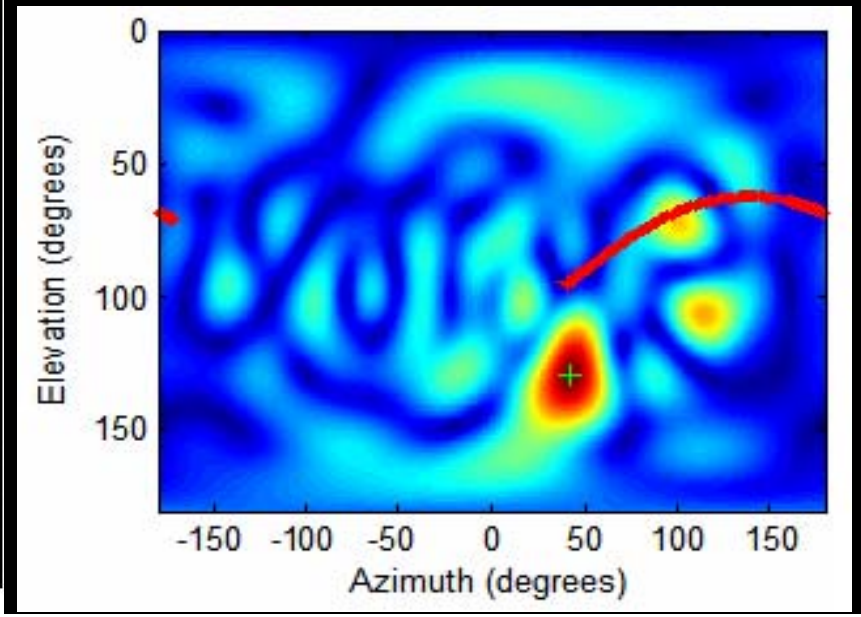
- In a central projection camera the straight line joining an object point and its image on the pixel plane passes through the camera center of projection



Camera-Spherical Array Epipolar Geometry

- As the array and camera are both central projection devices, corresponding points lie on an epipolar plane
- A calibration target containing a microspeaker and a light emitting diode on a wand (right) was constructed
- Epipolar lines from the array in the camera (left), and camera in the array (right) are shown as red lines below





Demonstration

- Using the calibrated camera/array, face detection, and a face template, localize speaker in video
- Epipolar line from the video in soundfield image provides a region for beamformer to search for
- Using this information the microphone array can lock on to a weak sound source, in the presence of a distracting source, and beamforming can suppress the distracter
- Movie shows a subject speaking while a loud music source plays. The video shows the epipolar line of the loud source from the array in the camera image
- The soundfield movie shows the intensity of the sound at a single frequency. Peaks in the magnitude are seen at the music source and speech source, and periodically in the walls from reverberation
- Speech is not understandable because of the loud music in the single microphone recording
- The beamformed speech, which uses the video information to locate the weaker sound source, is intelligible