SONICOM
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# TECHNICAL REPORT TR3.1 BRT REGULAR GRID: DISTRIBUTION OF POINTS IN THE SPHERE USED BY THE BINAURAL RENDERING TOOLBOX

SONICOM

Transforming auditory-based social interaction
and communication in AR/VR

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| **TR3.1 Title** | BRT REGULAR GRID: DISTRIBUTION OF POINTS IN THE SPHERE USED BY THE BINAURAL RENDERING TOOLBOX |
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## Abbreviations and Acronyms

| | |
|---|---|
| HRTF | Head Related Transfer Function |
| HRIR | Head Related Impulse Response |
| DTF | Directivity Transfer Function |
| SOFA | Spatially Oriented Format for Acoustics |
| BRT | Binaural Rendering Toolbox |

# Executive Summary

This report introduces a specific grid structure to be used by BeRTA (Binaural Rendering Tool App) to improve efficiency and processing speed in binaural rendering. It applies both to Head Related Transfer Functions (HRTF) of the listeners and Directivity Transfer Functions (DTF) of the sources. The grid ensures a quasi-regular distribution of measurement points with a given step between points. It is based on uniform elevation steps and variable azimuth steps. This way, the grid's design reduces points near the poles with respect to a uniform distribution in both azimuth and elevation, improving efficiency without compromising accuracy.



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# 1 Context and aims.

During the real time process of binaural rendering, to improve efficiency and processing speed, the BRT Library (Binaural Rendering Tool) needs to know exactly which points conform the HRTF and DTF in order to find as fast as possible those to be used in the interpolation process.

The purpose of this report is to present a specific quasi-regular grid structure that has been designed to uniformly cover the whole surface of the sphere and to facilitate finding the nearest points to a given arbitrary one. The *samplingStep* is the only parameter to define this grid, being the intended angular separation between two adjacent points at the equator or two adjacent points in the median plane (azimuth=0).

# 2 Grid Characteristics

## 2.1 Elevation Steps

In the case of Elevation, the grid consists of uniform steps, ensuring the inclusion of points along the horizontal plane (elevation = 0). The elevation range spans from -90 to 90 degrees.

Firstly, the number of rings (*R*) in one hemisphere is calculated by rounding up to the nearest integer the division of 90 degrees by the sampling step (1). Later, 90 degrees is divided by the number of rings, resulting in the elevationStep, the effective step for elevation (2). Importantly, this step remains consistent across the entire range, while always including points on the horizontal plane.

$$R = ceil\left(\frac{90}{samplingStep}\right) \qquad (1)$$

$$elevationStep = \frac{90}{R} \qquad (2)$$

## 2.2 Azimuth Steps

Unlike the uniform elevation steps, the azimuthStep is different at different elevations within the grid. To determine the azimuth step for each elevation, firstly, the number of divisions in the equator ($D_e$) is calculated. This is achieved by dividing 360 degrees by the sampling step and rounding up to the nearest integer (3).

$$D_e = ceil\left(\frac{360}{samplingStep}\right) \qquad (3)$$

Next, a reconstruction process is carried out, multiplying the number of divisions by the cosine of the elevation at which the point is located ($elevation_i$) and taking the integer above using the method ceil(x) (4). This provides the integer number of divisions in azimuth specific to that elevation I ($D_i$).

$$D_i = ceil\left(D_e * \cos\left(\frac{elevation_i * \pi}{180}\right)\right) \qquad (4)$$



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By dividing 360 degrees by this calculated number of divisions, the actual azimuth step for the given elevation is obtained (5). The azimuth steps start from azimuth = 0, ensuring that points are distributed throughout the front median plane.

$$azimuthStep_i = \frac{360}{D_i} \qquad (5)$$

The proposed grid distribution, which illustrates the spatial arrangement of points, is shown in Figure 1 and Figure 2 for a resamplingStep of 10 degrees.

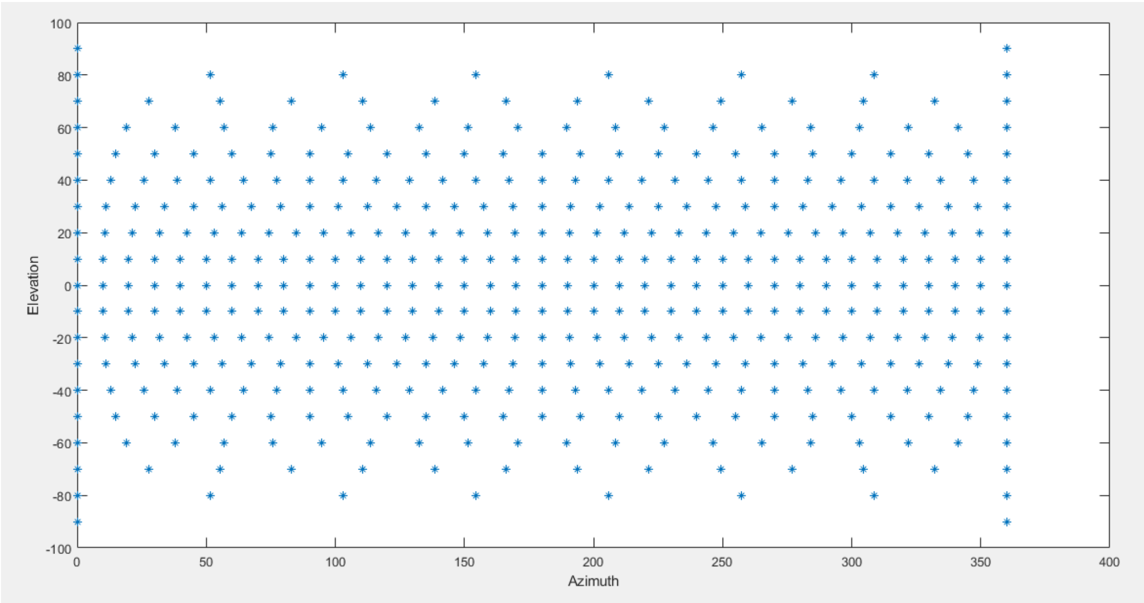


*Figure 2: Sphere Grid Distribution for a samplingStep of 10 degrees (2D representation)*

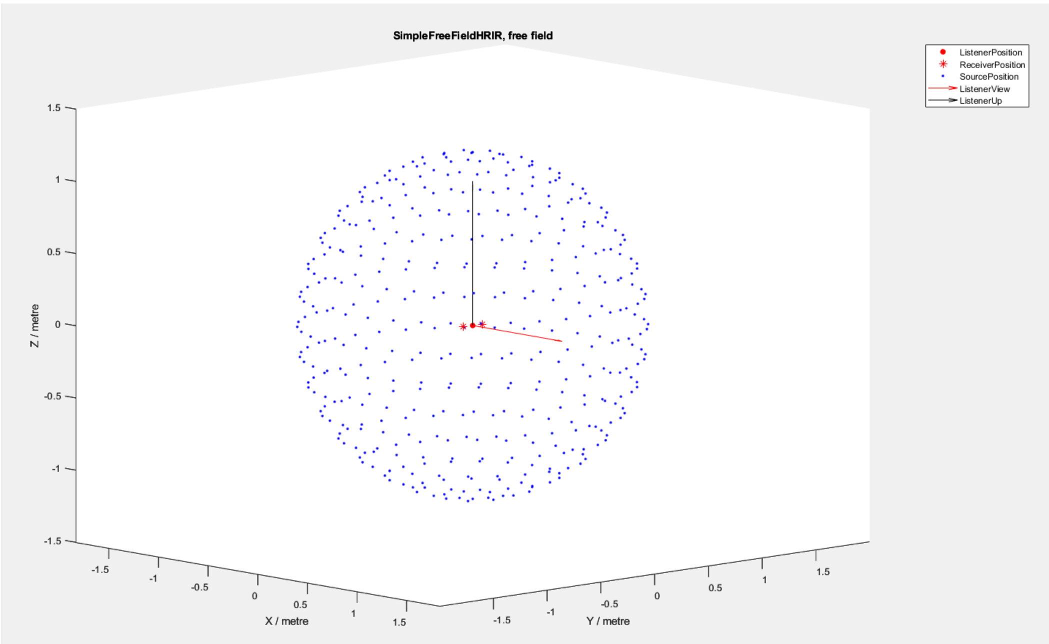


*Figure 1: 3D representation of the Grid Structure for a samplingStep of 10 degrees*



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# 3 Grid structure and benefits

The proposed grid structure offers several advantages for efficient and accurate binaural rendering.

- It provides a well-defined set of locations to make easy to select the nearest available points to a given location, allowing a high efficiency in this searching process.
- It keeps a uniform spatial resolution in the surface of the sphere.
- That resolution can be chosen selecting the parameter resamplingStep.

# 4 Appendices

## 4.1 Table of Figures





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