• **PE**: Positional Encoding Matrix

• i : Current Row

• I : Total Rows

• j : Current Column

• J : Total Columns

• $oldsymbol{\delta}$: Current Hidden Dimension

• dm: Hidden Size of Model

• λ : Odd/Even Check for Row/Col

$$oldsymbol{PE}[\,oldsymbol{\delta},\,oldsymbol{i},\,oldsymbol{j}\,]\in\mathbb{R}^{d_m imes I imes J}$$

$$\begin{cases} \sin\left(i\cdot\mathbf{e}^{-\delta\left(\frac{\log(10000)}{dm}\right)}\right) + \sin\left(j\cdot\mathbf{e}^{-\delta\left(\frac{\log(10000)}{dm}\right)}\right) & \text{if } \lambda = [0,\,0] \\ \sin\left(i\cdot\mathbf{e}^{-\delta\left(\frac{\log(10000)}{dm}\right)}\right) + \cos\left(j\cdot\mathbf{e}^{-\delta\left(\frac{\log(10000)}{dm}\right)}\right) & \text{if } \lambda = [0,\,1] \end{cases} \\ = \begin{cases} \cos\left(i\cdot\mathbf{e}^{-\delta\left(\frac{\log(10000)}{dm}\right)}\right) + \sin\left(j\cdot\mathbf{e}^{-\delta\left(\frac{\log(10000)}{dm}\right)}\right) & \text{if } \lambda = [1,\,0] \end{cases} \\ \cos\left(i\cdot\mathbf{e}^{-\delta\left(\frac{\log(10000)}{dm}\right)}\right) + \cos\left(j\cdot\mathbf{e}^{-\delta\left(\frac{\log(10000)}{dm}\right)}\right) & \text{if } \lambda = [1,\,1] \end{cases} \end{cases}$$

$$\cos\left(i\cdot\mathrm{e}^{-\delta\left(\frac{\log(10000)}{dm}\right)}\right) + \sin\left(j\cdot\mathrm{e}^{-\delta\left(\frac{\log(10000)}{dm}\right)}\right) \quad \text{if } \lambda = [\,1,\,0\,]$$

$$\cos\left(i\cdot\mathrm{e}^{-\delta\left(\frac{\log(10000)}{dm}\right)}\right) + \cos\left(j\cdot\mathrm{e}^{-\delta\left(\frac{\log(10000)}{dm}\right)}\right) \quad \text{if } \lambda = [1,\,1]$$

Where
$$\boldsymbol{\lambda} = [\,i,\,j\,]\,\%\,2$$