

Motivation

- Advancing electromagnetics education requires more intuitive and interactive tools for visualizing complex electromagnetic phenomena.
- This research adapts MATLAB tools into a virtual reality (VR) environment.
- Developed modules for dipole antenna radiation patterns, a one-dimensional finite-difference time-domain (FDTD) method, electric field polarization, and plane wave propagation.

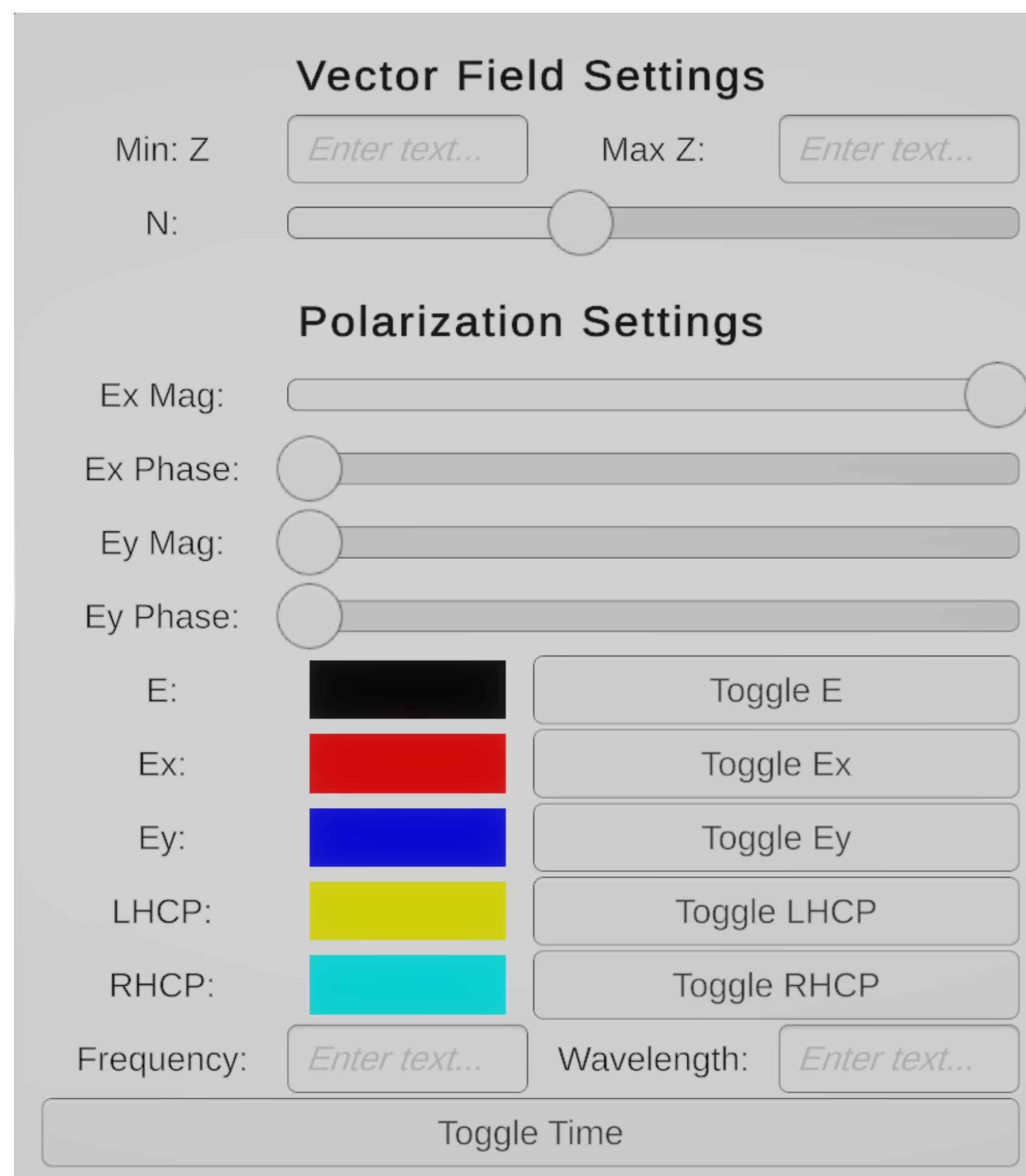
Methods and Materials

- Developed modules using the Unity game engine and integrated toolkits for deployment on Meta Quest headsets.
- Developed C# scripts for calculating electromagnetic fields, rendering custom meshes in spherical coordinates, plotting 3D vector fields, and updating components in real time.
- Designed user interfaces and implemented a wrist-mounted menu system for user input.
- Polarization and plane wave modules shown below.

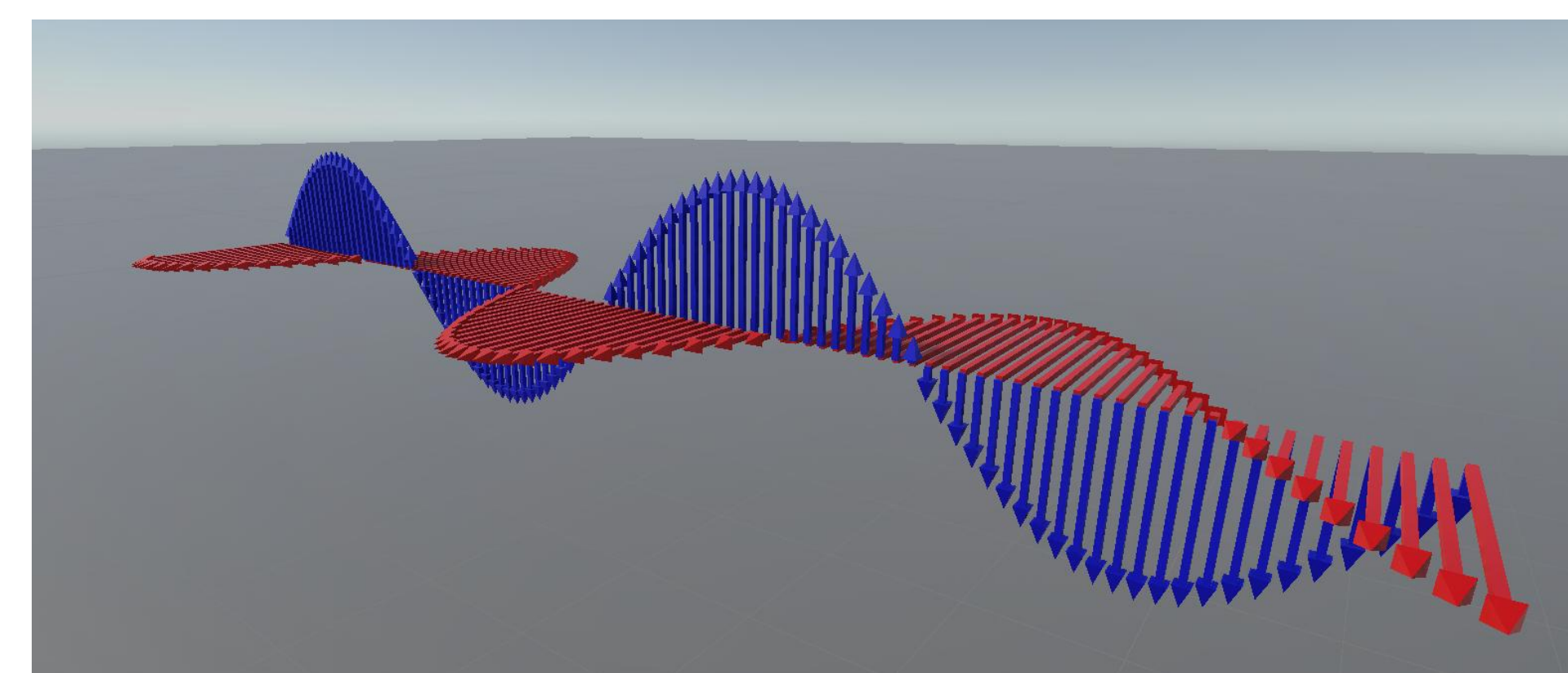
Conclusions and Future Work

- Results demonstrate effective adaptations of MATLAB apps into VR, enabling real-time updating and interaction in a three-dimensional space.
- Future work will focus on expanding the library of supported simulations and improving the user experience in VR.
- More work is needed for implementing modules in augmented reality (AR) to project simulations into the real world, allowing for a more interactive experience.

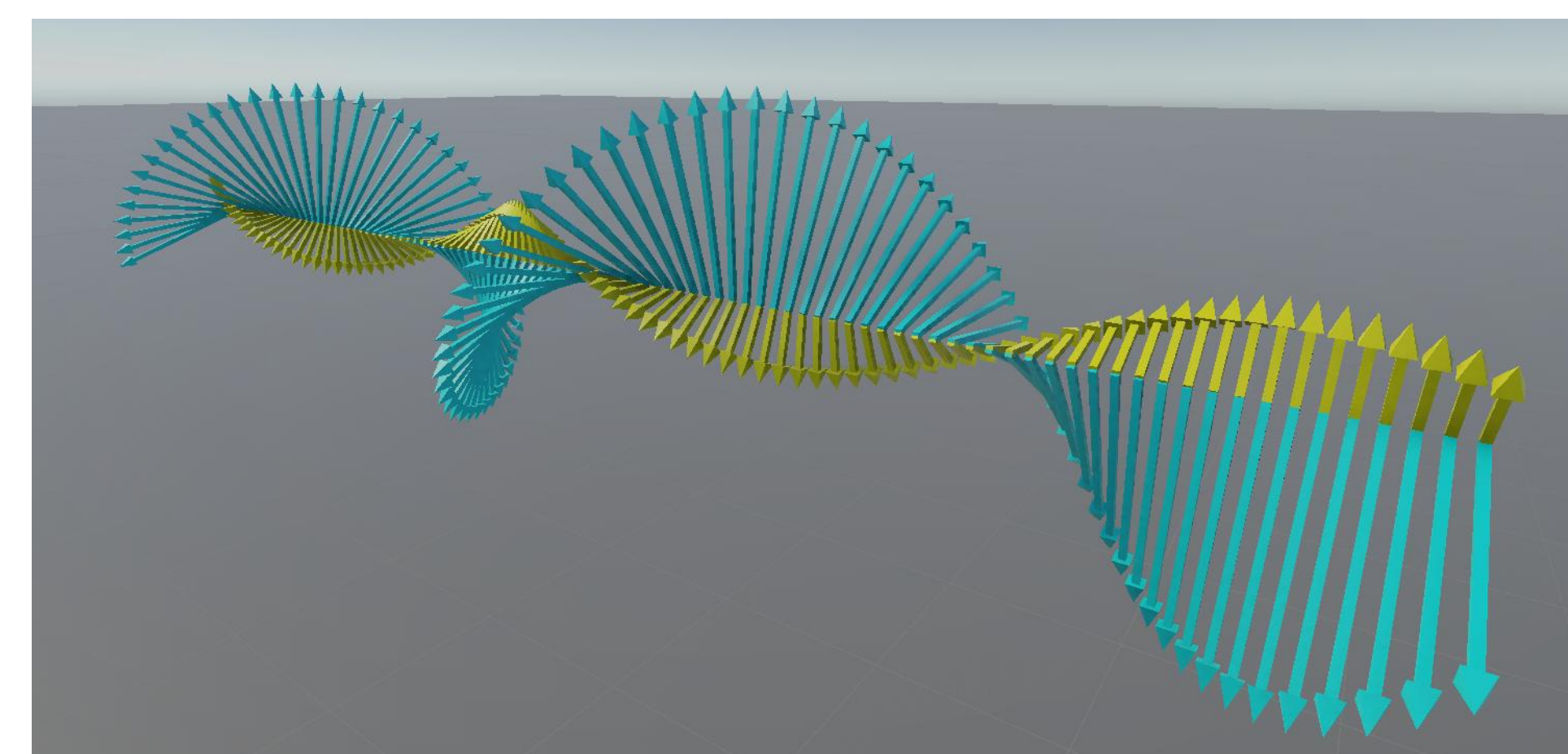
Polarization Module



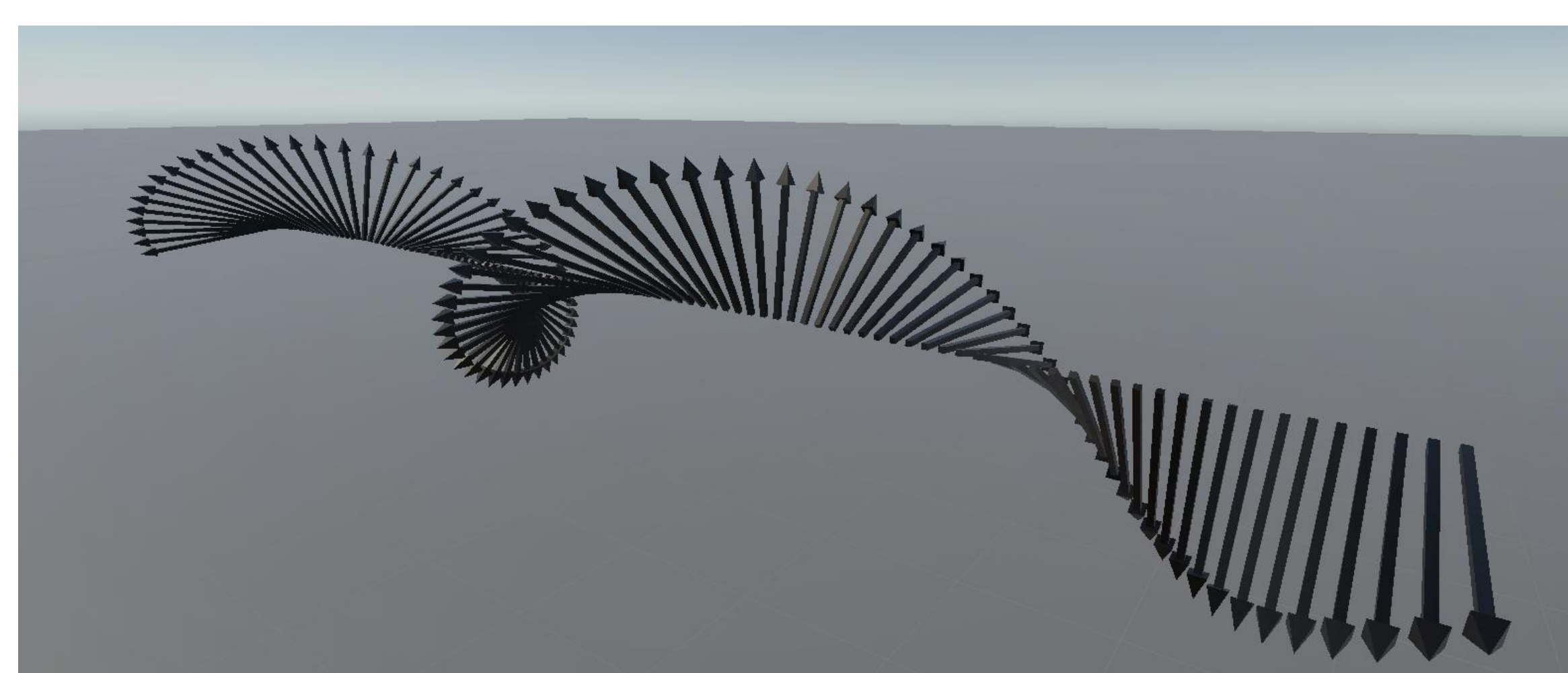
User interface for polarization module



Electric field x and y components



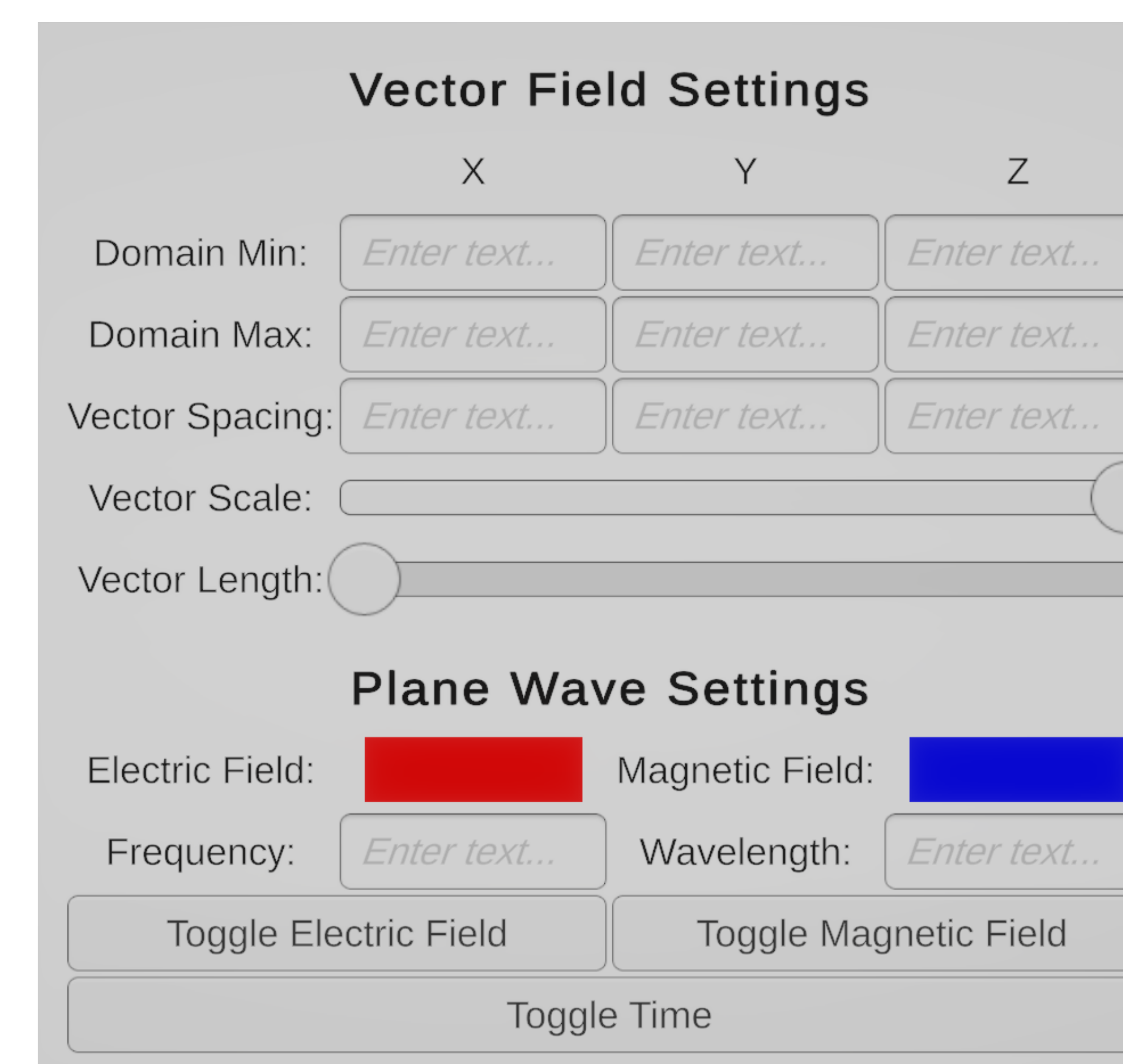
Decomposition into LHCP and RHCP fields



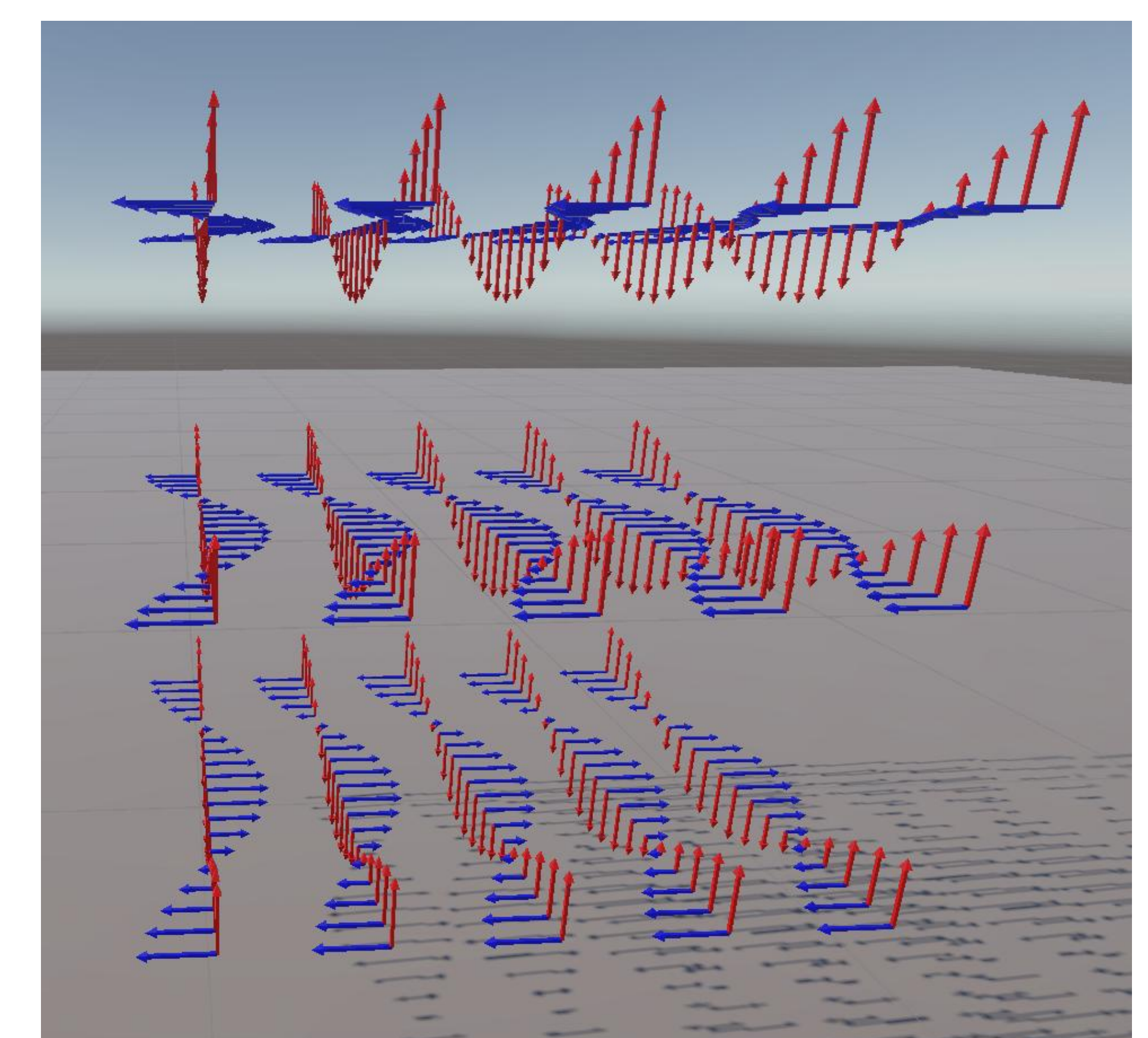
Total electric field

- User controls the amplitude and phase of x and y components of the electric field propagating in +z.
- Calculates the total electric field vector and the decomposition into left-handed circular polarized (LHCP) and right-handed circular polarized (RHCP) waves.
- Visibility toggles for total electric field, x, y, LHCP, and RHCP component vectors.
- Time toggle to pause and continue electric field updates in time.

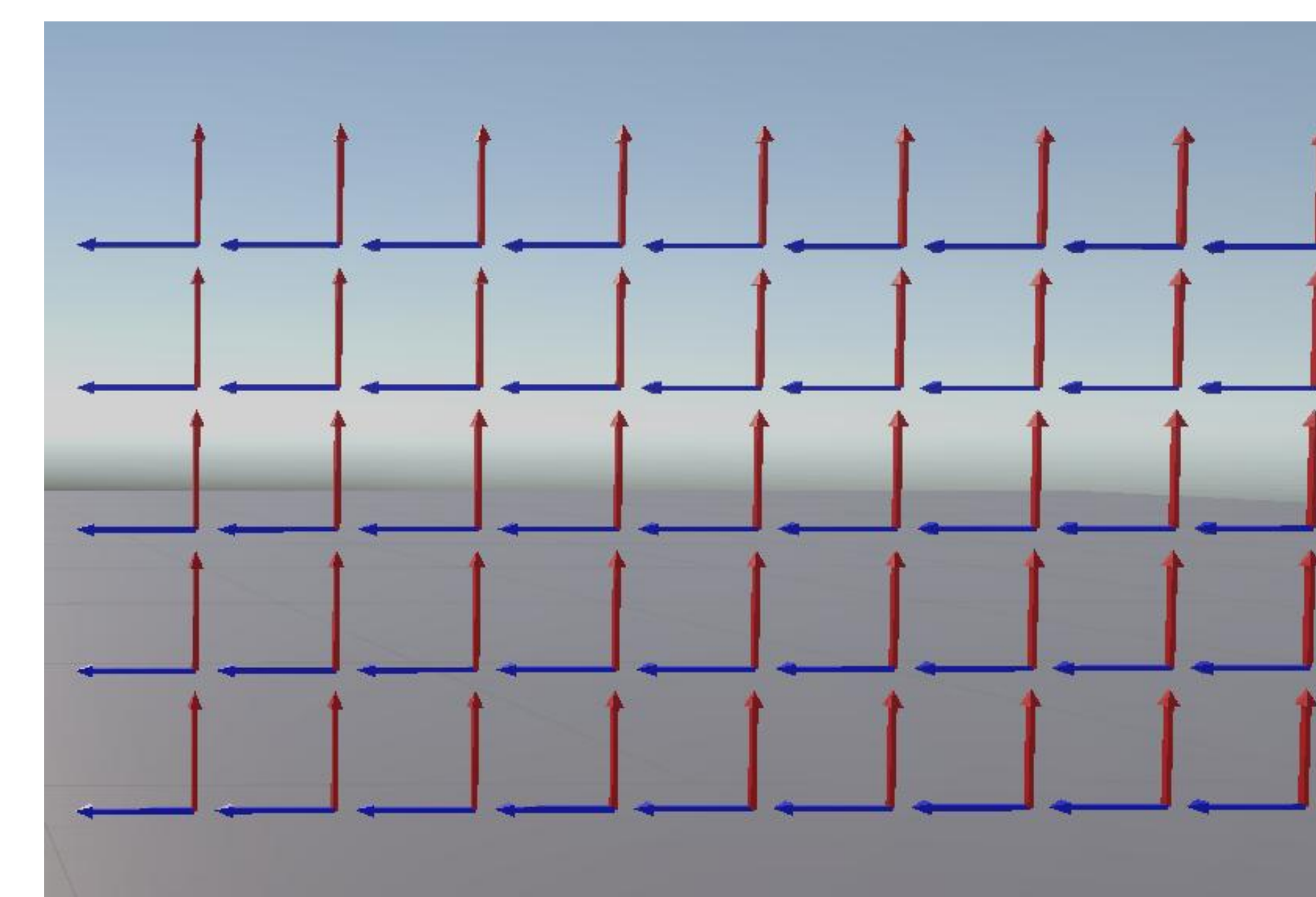
Plane Wave Propagation Module



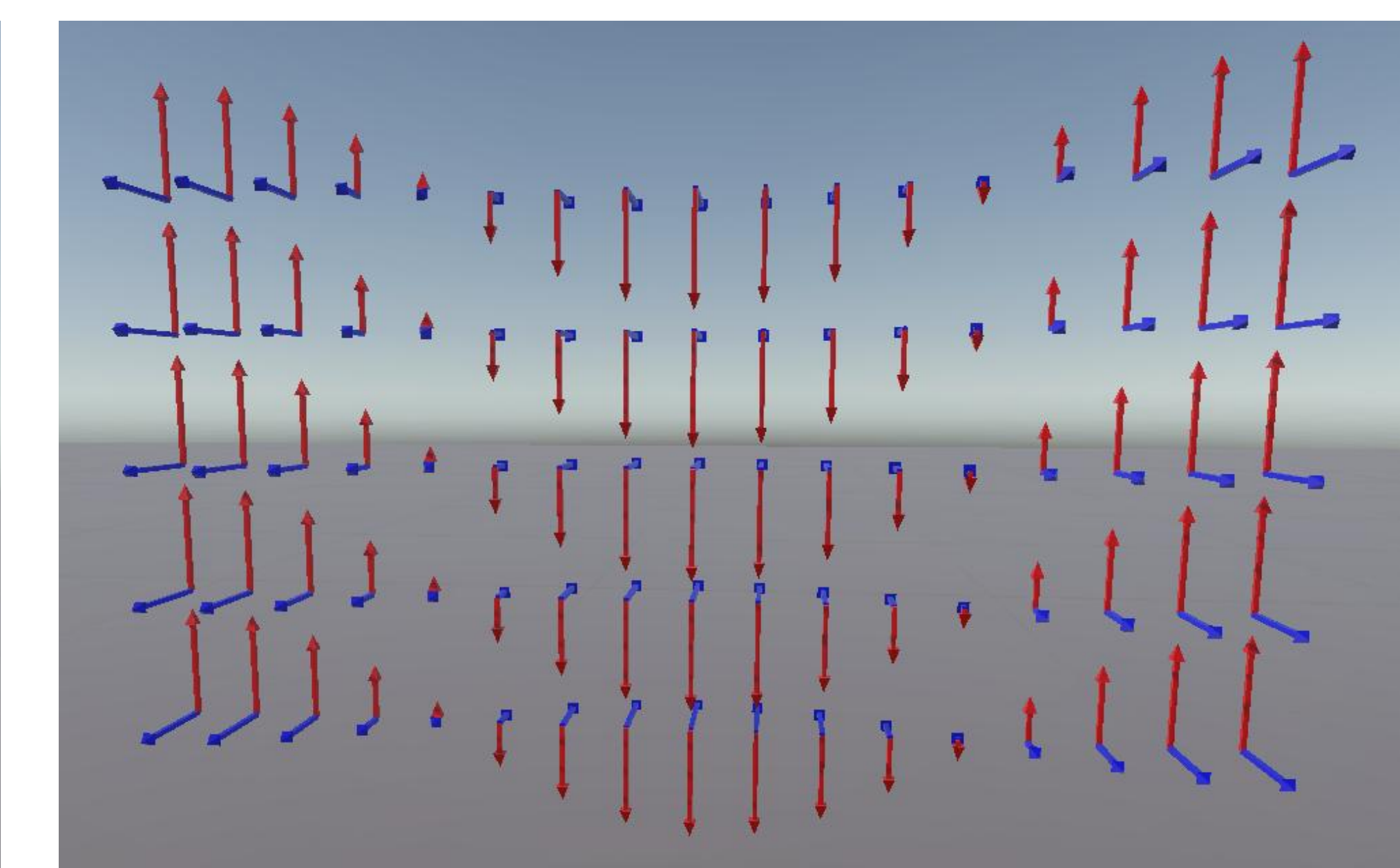
User interface for plane wave module



Plane wave vector field viewed from +z



Plane wave configured as xy plane cut



Plane wave configured as yz plane cut

- User controls the density and size of a vector field showing electric and magnetic field components of a plane wave propagating in +z.
- Allows adjusting vector sizes for enhanced visibility.
- Visibility toggles for electric and magnetic field vectors.
- Time toggle to pause and continue field updates in time.