

We develop a new matrix-free time-domain method, which requires no matrix solution, in unstructured meshes for general 3-D electromagnetic analysis. The method handles arbitrary unstructured meshes with the same ease as a finite-element method. Meanwhile, it is free of matrix solutions manifested by a naturally diagonal mass matrix, just like a finite-difference time-domain method. Different from our previous formulation where traditional curl-conforming vector bases are employed, modified vector bases are developed in this paper to directly connect the unknown coefficients of the vector basis functions employed to represent  $E$  (or  $H$ ) with the unknowns obtained from the curl of  $H$  (or  $E$ ), without any need for transformation. The proposed method employs only a single mesh. It does not require any interpolation and projection to obtain one field unknown from the other. Its accuracy and stability are guaranteed theoretically. Numerous experiments on unstructured triangular prism and tetrahedral meshes, involving both homogeneous and inhomogeneous and lossy materials, demonstrate the generality, accuracy, stability, and computational efficiency of the proposed method. The modified higher order vector bases developed in this paper can also be used in any other method that employs higher order bases to obtain an explicit relationship between unknown fields and unknown coefficients of vector bases.