In this article, Fourier transforms of tree-level gluon amplitudes in twistor space are carried out, by use of a recently developed expression for the gluon amplitudes where the dual superconformal symmetry is transparent. The Fourier transforms are also called the twistor transforms as the amplitudes are obtained in a twistor-space based spinor-helicity formalism. By performing such transformations, the authors are able to discuss geometric properties of the amplitudes with emphasis on their (dual) superconformal invariance. The resultant geometric interpretation suggests that there exists a hidden geometric origin in the gluon amplitudes in general.