## 6. 3D Imaging of Bifurcation Surfaces in Nonlinear Differential Equation

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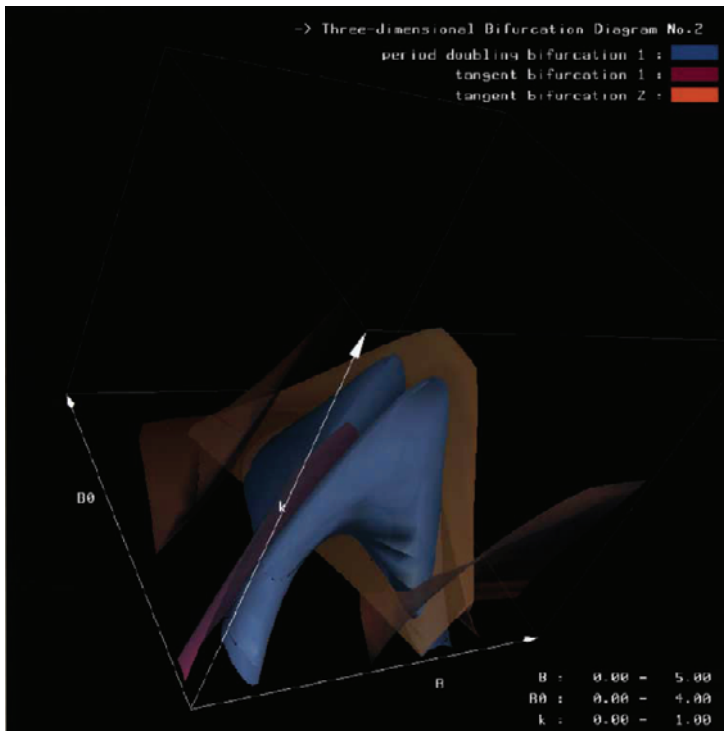
Solutions of dynamical systems described by nonlinear differential equations frequently change their behavior as the parameter varies, e.g., the period has doubled, the solution disappears, and sometimes chaotic motion is appeared. The change of stability for the solution is called bifurcation, and it is important to obtain the bifurcation parameter values to grasp concrete properties of the dynamical system. We develop a visualization system representing solid models as structures of such bifurcation sets in a 3D parameter space by using OpenGL. Here we show the bifurcation surfaces of Duffing's equation. There are period-doubling (blue objects) and tangent bifurcation (others) sets for periodic solutions. It is possible to estimate the parameter location where the system behaves chaotically since there exist period-doubling cascades inside of the period-doubling bifurcation sets.