



Figure 6: Visual integration under good continuation involves the question of how a measurement of orientation at one retinal position relates to another measurement of orientation at a nearby retinal position. Formally, this amounts to specifying how a tangent (orientation measurement) at position \vec{q} relates to another nearby tangent displaced by a vector \vec{V} . This tangent displacement amounts to rotation, and as shown above, this rotation can differ for different displacements. Formally, the rotation is specified locally by the covariant derivative $\nabla_{\vec{V}}$, and the mathematical analysis is facilitated by defining an appropriate coordinate frame. Shown is the Frenet basis $\{\hat{E}_T, \hat{E}_N\}$, where \hat{E}_T corresponding to a unit vector in the orientation's tangential direction and \hat{E}_N corresponds to a unit vector in the normal direction. Associated with this frame is an angle θ defined relative to external fixed coordinate frame (the black horizontal line). The covariant derivative specifies the frame's initial rate of rotation for any direction vector \vec{V} . The four different cases in this figure illustrate how this rotation depends on \vec{V} both quantitatively (i.e., different magnitudes of rotation) and qualitatively (i.e., clockwise, counterclockwise, or zero rotation). Since displacement is a 2D vector and $\nabla_{\vec{V}}$ is linear, two numbers are required to fully specify the covariant derivative. These two numbers describe the initial rate of rotation in two independent displacement directions. Using the Frenet basis once again, two natural directions emerge. A pure displacement in the tangential direction (\hat{E}_T) specifies one rotation component, and a pure displacement in the normal direction (\hat{E}_N) specifies the other component. We call them the tangential curvature (κ_T) and the normal curvature (κ_N), respectively. If visual integration based on good continuation relates to 2D patterns of orientation, then both of these curvatures are required. For good continuation along individual curves, only the tangential curvature is required since displacement is possible only in the tangential direction (that is, along the curve only).