

orientation with respect to gravity, such as measured by an accelerometer for instance. Another use case is visual odometry using a monocular camera only, in which case absolute scale is unobservable between two frames, but translation direction is.

A direction in space is conveniently represented by a unit 3-vector, i.e., $p = \begin{bmatrix} x & y & z \end{bmatrix}^T$ with the nonlinear constraint $x^2 + y^2 + z^2 = 1$. In other words, the manifold of directions in 3D space is the **Sphere in 3D**, typically denoted S^2 . It is a *two-dimensional* manifold, as the nonlinear constraint takes away one degree of freedom, and indeed, the sphere is intuitively familiar to us as a two-dimensional surface.