



Figure XII.7: The rate of change of the position \mathbf{s}_x of point x with respect to the joint angle θ_y is calculated in terms of rotation around the axis \mathbf{w}_y of the joint y as $\mathbf{w}_y \times (\mathbf{s}_x - \mathbf{s}_y)$. The axis \mathbf{w}_y is pointing out of the page, so $\mathbf{w}_y \times (\mathbf{s}_x - \mathbf{s}_y)$ has the right direction for the partial derivative. Since \mathbf{w}_y is a unit vector, $\mathbf{w}_y \times (\mathbf{s}_x - \mathbf{s}_y)$ also has the right magnitude. This calculation works for any x and y , not for just end effectors and the root link.