1 Summary Denavit-Hartenberg Frames

- There must be one frame for each joint and one frame for the end effector. However, there can be more frames, if wanted.
- Origins of frames should be located at the center of their respective joints. This, however, is not always possible.
- The origin of a frame i can be moved along axis z_i.
- Axis z_i must be the axis of rotation for a revolute joint, or the axis of translation for a prismatic joint.
- The direction of z_i follows from the right-hand-rule for revolute joints and points towards positive movement for prismatic joints.
- The x_0 axis of the first frame is a free choice. The x_i axes (with $i > 0$) of subsequent joints are constrained.
- Axis x_i must be perpendicular to axes z_i and z_{i-1}.
- The direction of x_i follows from the cross product $x_i = z_i \times z_{i-1}$.
- If axes z_i and z_{i-1} are parallel, the direction of x_i can be chosen freely. If possible, x_i should point in the same direction as x_{i-1} to achieve a simple transformation.
- The axis x_i must intersect axis z_{i-1}. If necessary, the origin of frame i has to be moved along axis z_i to meet this constraint.
- The y_i axis follows from the right-hand-rule.

2 Summary Denavit-Hartenberg Parameters

- The Denavit-Hartenberg parameters $(\theta_i, \alpha_i, r_i, d_i)$ define the transformation between frame $(i-1)$ and frame i. Therefore, $i \geq 1$.
- θ_i is the angle between axes x_{i-1} and x_i about axis z_{i-1}. This includes a possible static rotary offset and a rotation due to joint movement (if joint is revolute).
- α_i is the angle between axes z_{i-1} and z_i about axis x_i.
- r_i is the distance between origin of frame $(i-1)$ and origin of frame i along x_i.
- d_i is the distance between origin of frame $(i-1)$ and origin of frame i along z_{i-1} This includes a possible static translational offset and a translation due to joint movement (if joint is prismatic).