Provide Closed-loop Constraints for Digit

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<Objective>

XML is the MJCF modeling language used in MuJoCo or other physic engines. It provides 'anchor (https://mujoco.readthedocs.io/en/latest/XMLreference.html#equality-connect)' to provide closed loop in robot. However, URDF (Unified Robot Description Format, another type of XML format to represent robot models) does not offer way to provide constraints. Since URDF is used in PyBullet, PyBullet offer its own function to create connection (or provide closed-loops) between links (rigid bodies). However, its function requires the position of connection between two links, its required to manually calculate the connection point.

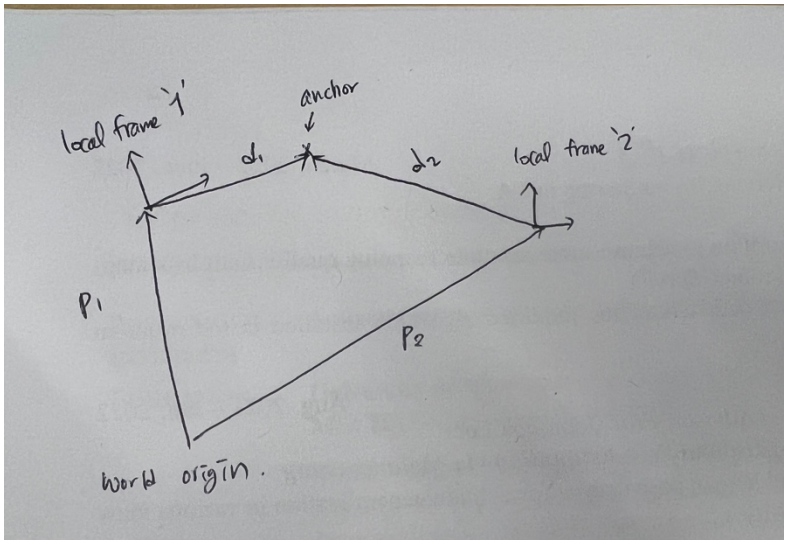
<Equation>

1. Variable

d1 : vector from origin to local frame 1 to anchor measured at local frame 1
d2 : vector from origin to local frame 2 to anchor measured at local frame 2
p1 : vector from world origin to local frame 1 origin measured at world frame
p2 : vector from world origin to local frame 2 origin measured at world frame

r1 : quaternion of local frame 1
r2 : quaternion of local frame 2

known variable : d1, p1, p2, r1, r2
variable to calculate : **d2**



2. Equation

R1 = quat2mat(r1)
R2 = quat2mat(r2)

d1_world = matmul(R1.T , d1) : distance of vector d1 measured at world frame

let d01 : vector from world origin to anchor point measured at world frame,
d01 = p1+d1_world

let d2_world : distance of vector d2 measured at world frame,
d2 _ world = d01 – p2. -**eq1**

also,
d2_world = matmul(R2.T , d2) -**eq2**

by comparing **eq1** and **eq2**,

d01 – p2 = R2.T * d2

so,
d2 = R2 * (d01-p2)

= quat2mat(r2) * ((p1 + R1.T * d1) -p2) **(ans)**