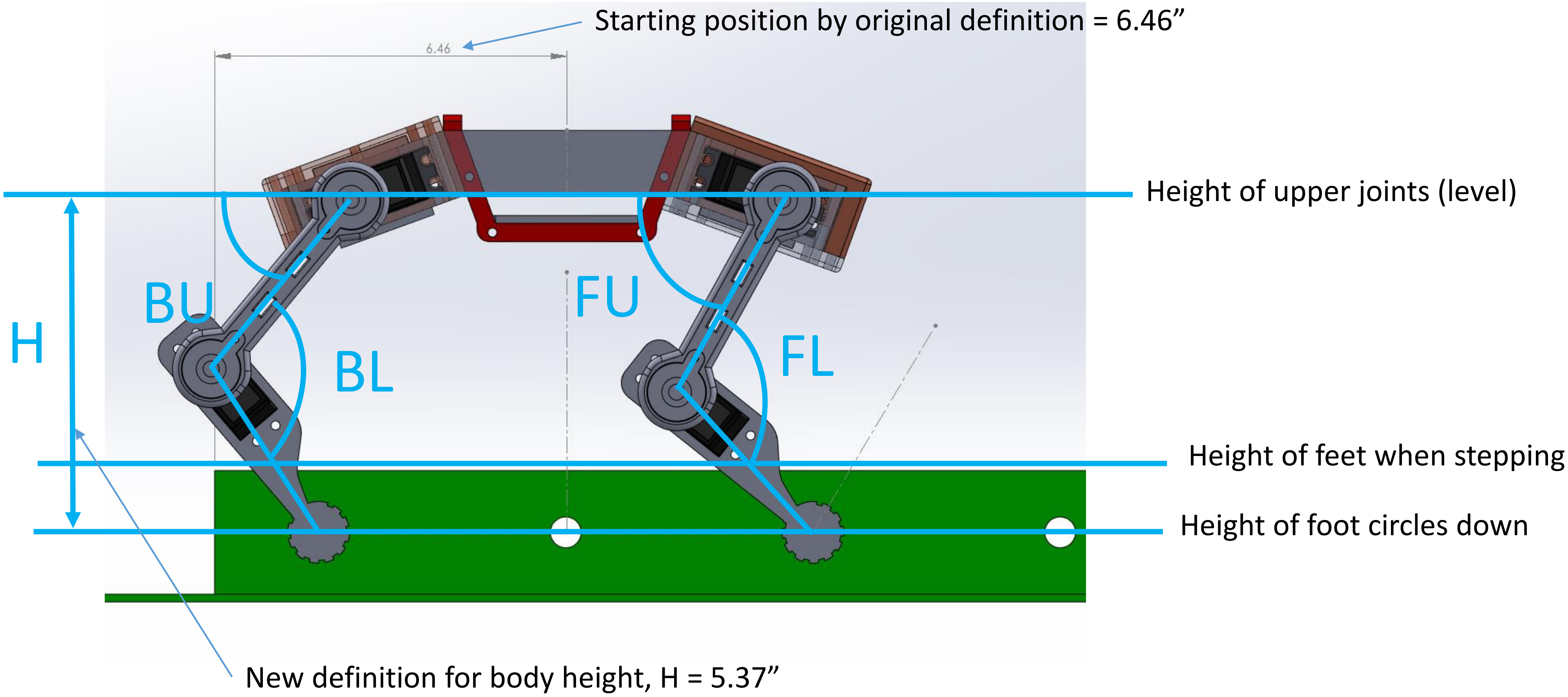
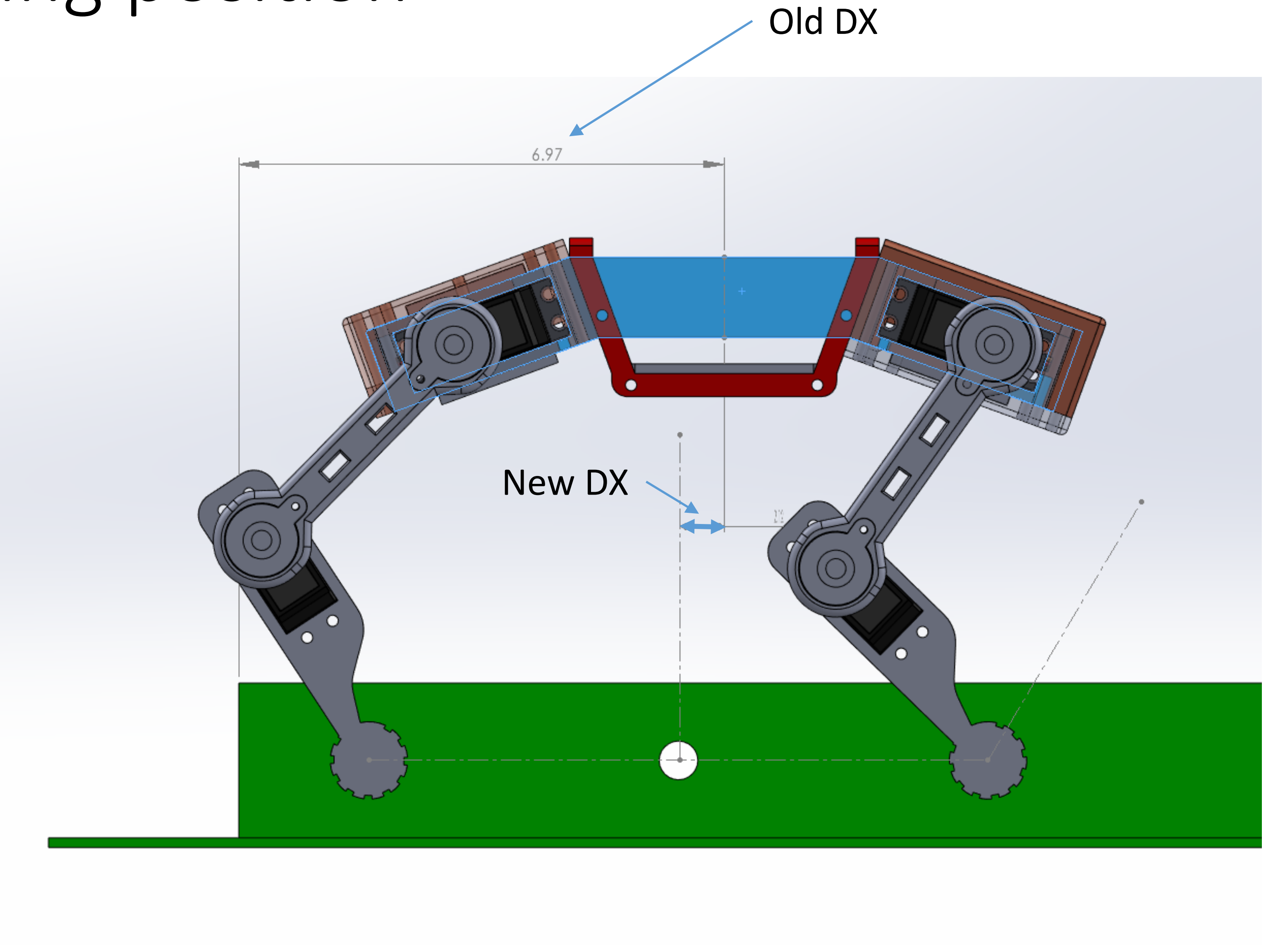
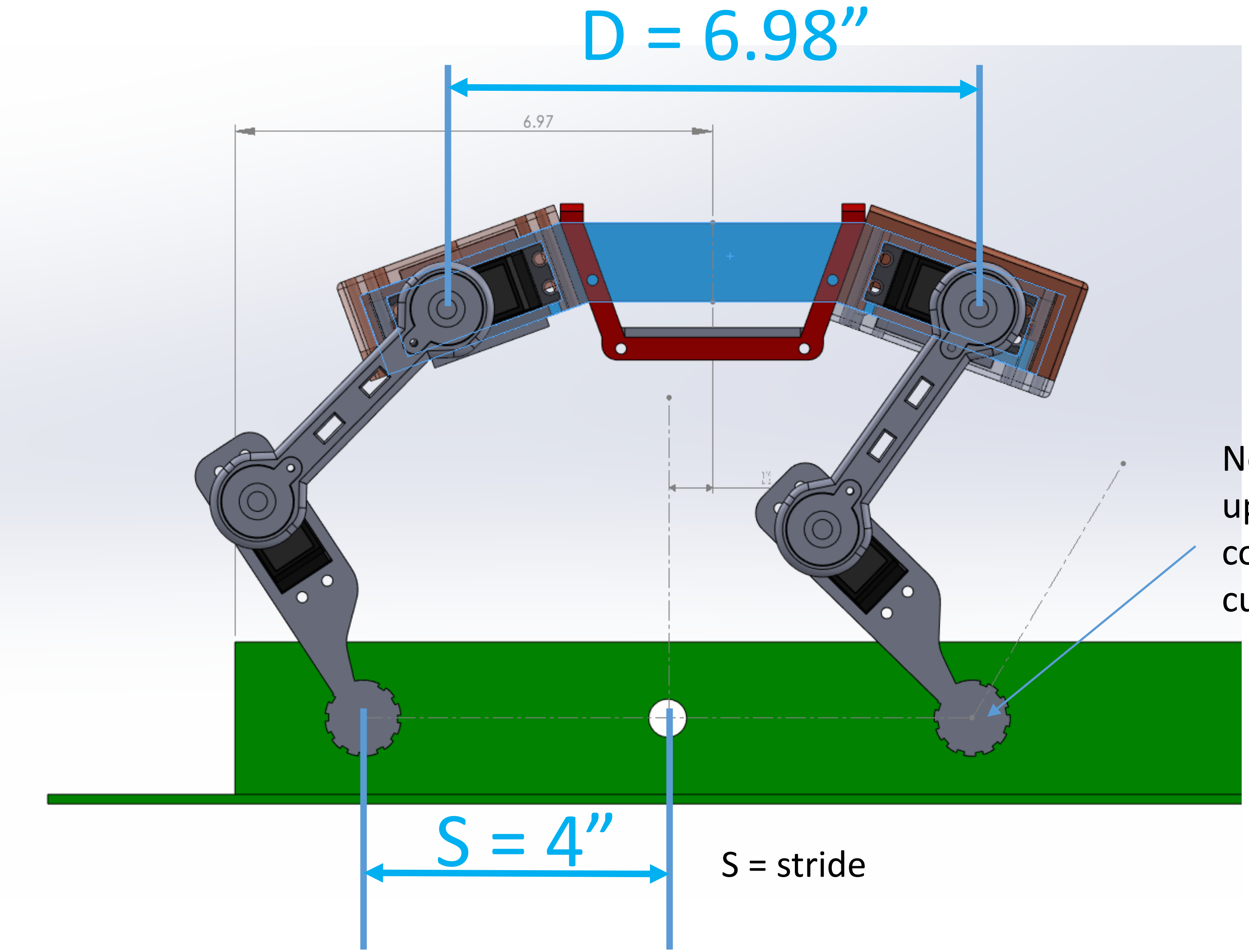
New Angle definitions shown at new baseline height definition and starting position



Redefining horizontal position to be offset from starting position



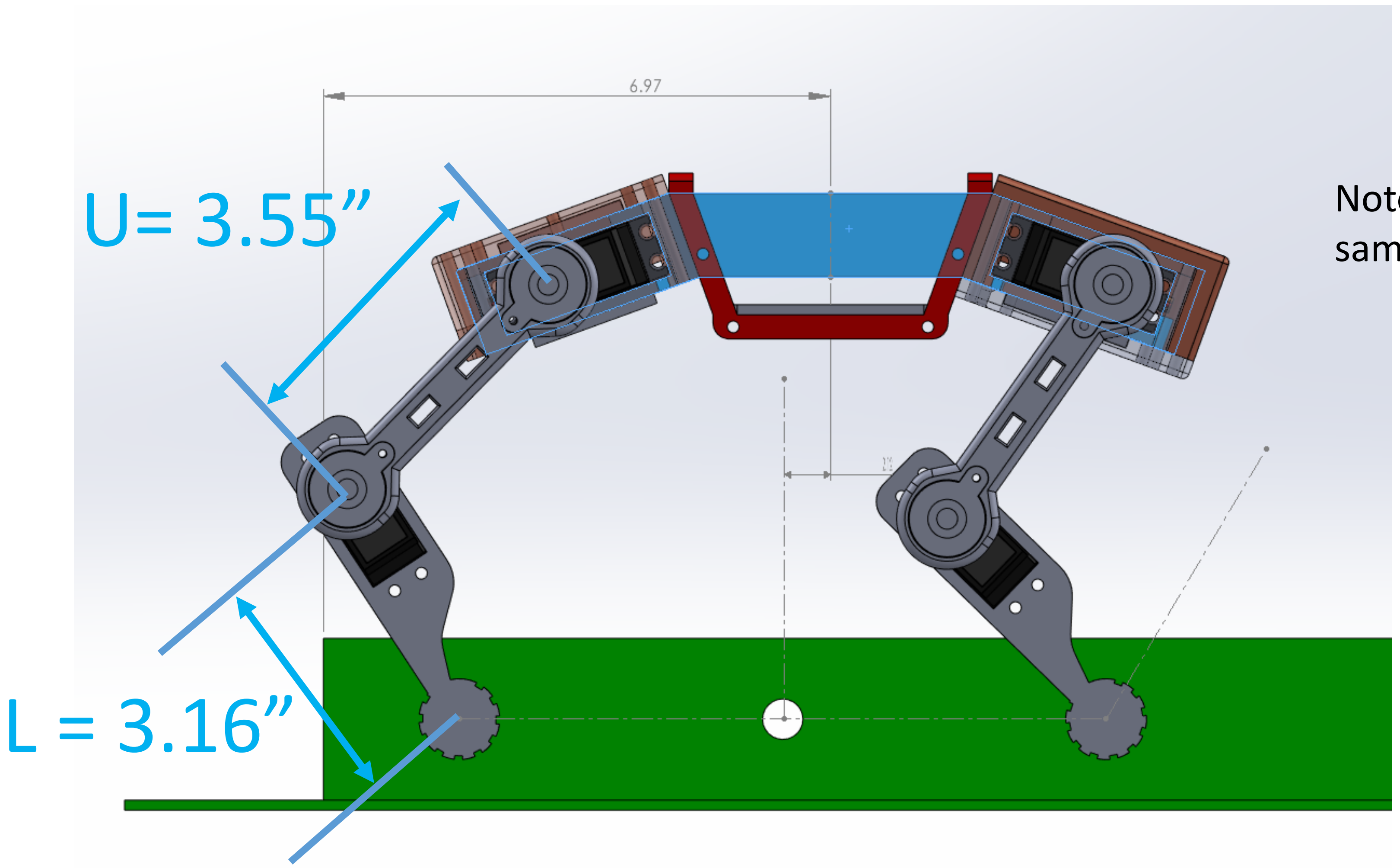
Stride is currently 4”, a bit more than D/2
Note starting position front and back angles are not equal



S = stride

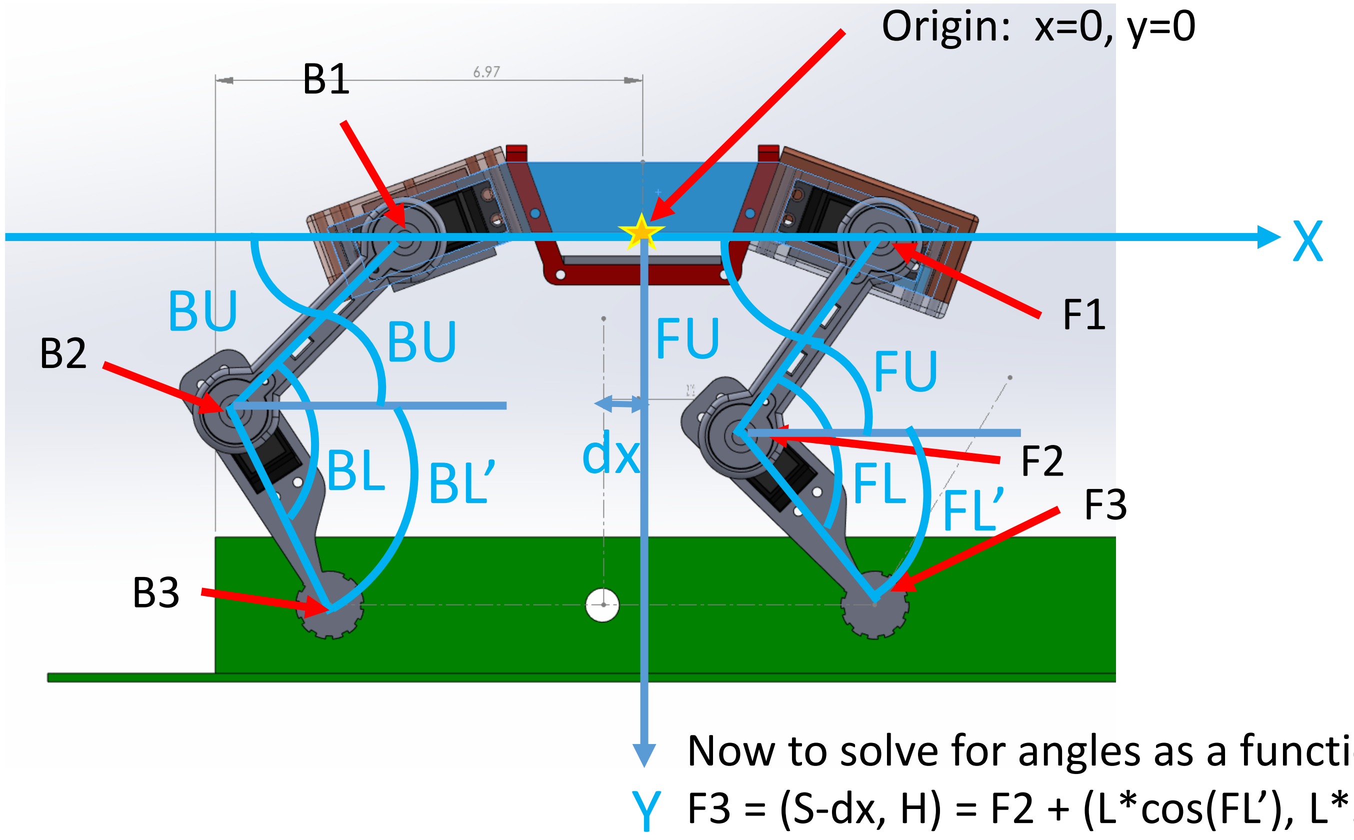
Note front foot is closer to upper joint (horizontally) compared to rear foot in this current starting position

Probably need limb length to do the math



Note front and rear limbs are same length in current design

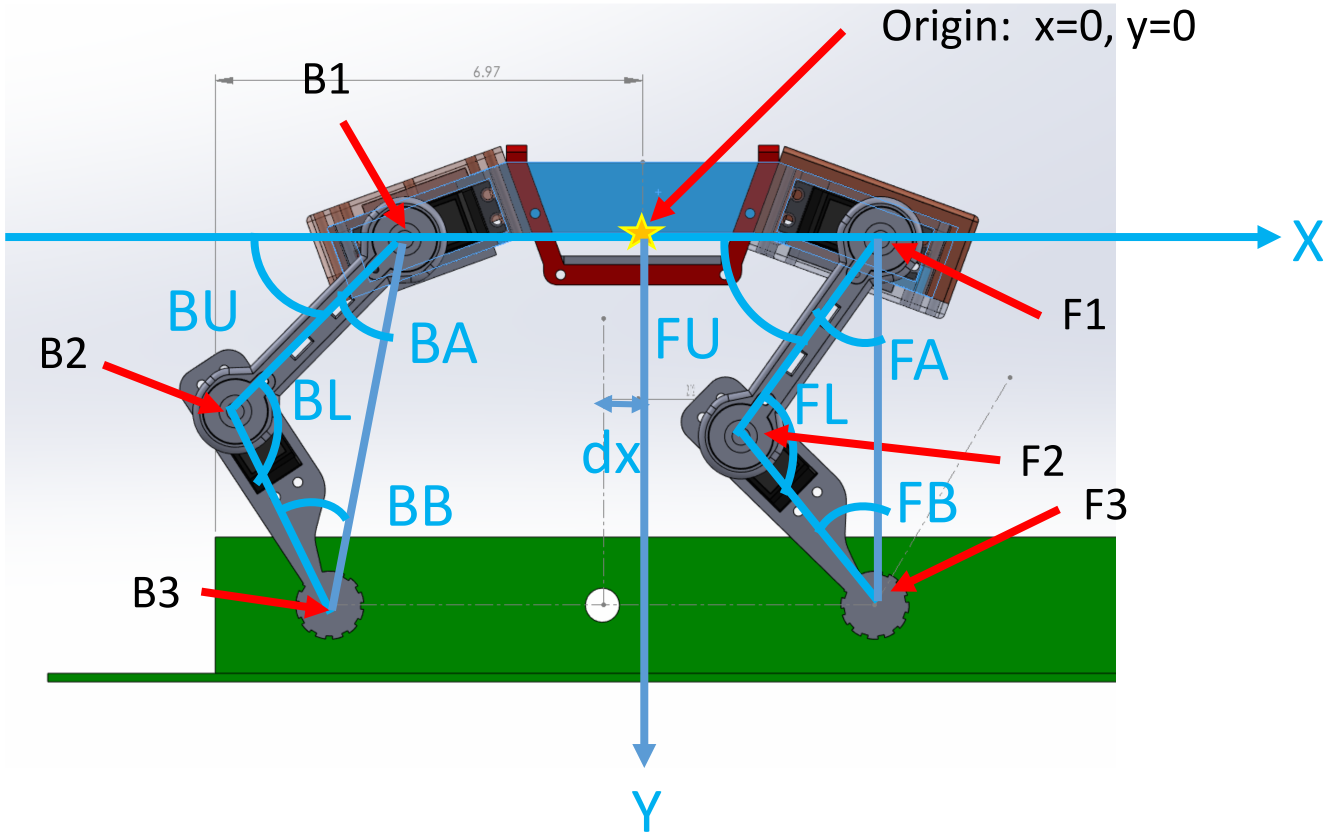
Need to calculate these angles as a function of dx and then splice in limb advancement
For robot's inertial frame of reference, making center of upper joints the origin point
Making down the positive Y direction



Vector Math:
B1 = (-D/2, 0)
B2 = B1 + (-U*cos(BU), U*sin(BU))
BL'=BL-BU
B3 = B2 + (L*cos(BL'), L*sin(BL'))
F1 = (D/2, 0)
F2 = F1 + (-U*cos(FU), U*sin(FU))
FL'=FL-FU
F3 = F2 + (L*cos(FL'), L*sin(FL'))

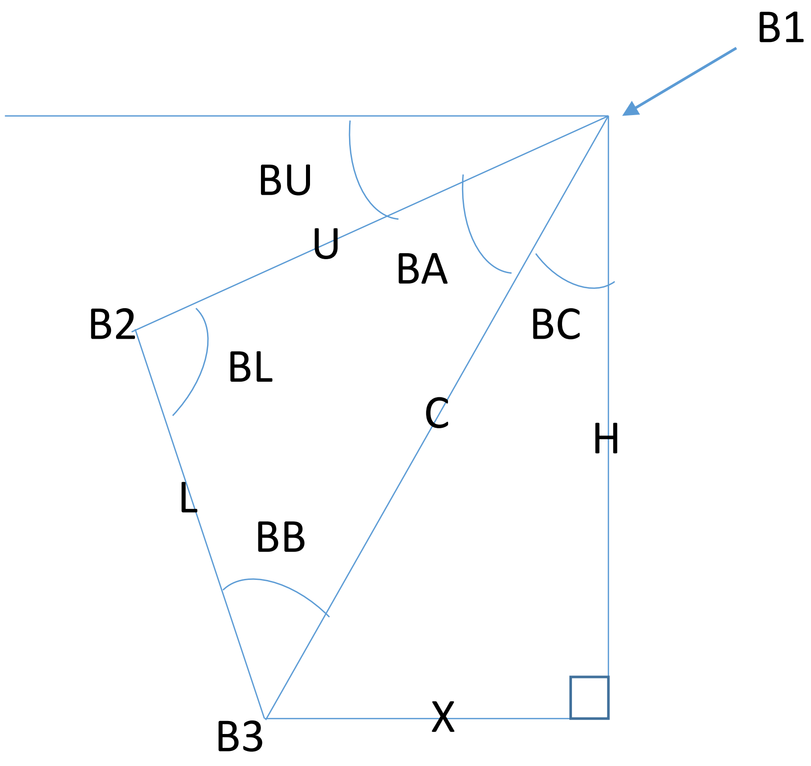
Now to solve for angles as a function of dx:
F3 = (S-dx, H) = F2 + (L*cos(FL'), L*sin(FL')) = F2 + (L*cos(FL-FU), L*sin(FL-FU))
F3x = S-dx = F2x + L*cos(FL-FU) = F1x –U*cos(FU) + L*cos(FL-FU)
S-dx = D/2 –U*cos(FU) + L*cos(FL-FU)
F3y = H = F2y + L*sin(FL-FU) = F1y + U*sin(FU) + L*sin(FL-FU)
H = U*sin(FU) + L*sin(FL-FU)
No way to solve this! What now? Try something else…

Found example of the math here: Inverse Kinematics: how to move a robotic arm (and why this is harder than it seems) · Applied Go



Define new angles: BA & BB , FA & FB

Math is a bit tricky… Need ArcCosine

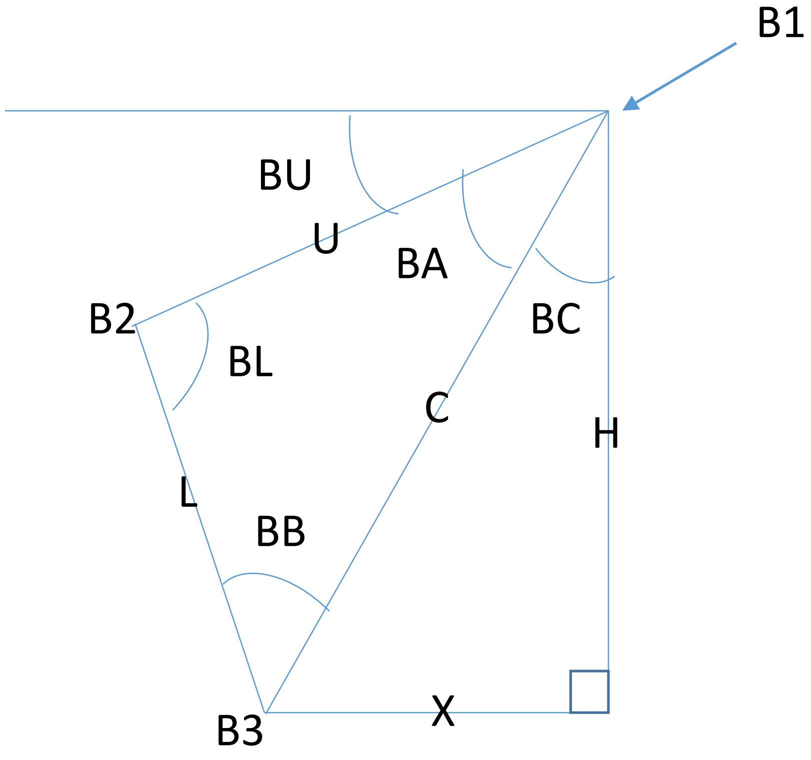


X=S-D/2+dx = known
H=known
Length C= sqrt(H*H+X*X) = known
U and L are known

Law of Cosines:
C*C = U*U + L*L -2*U*L*cos(BL)
BL = acos((U*U+L*L-C*C)/(2*U*L))
BC = acos(H/C)
BA = acos((U*U+C*C-L*L)/(2*U*C))
BU=90-BA-BC

Think can use same math for front limbs…

Checking the math, distances in mils



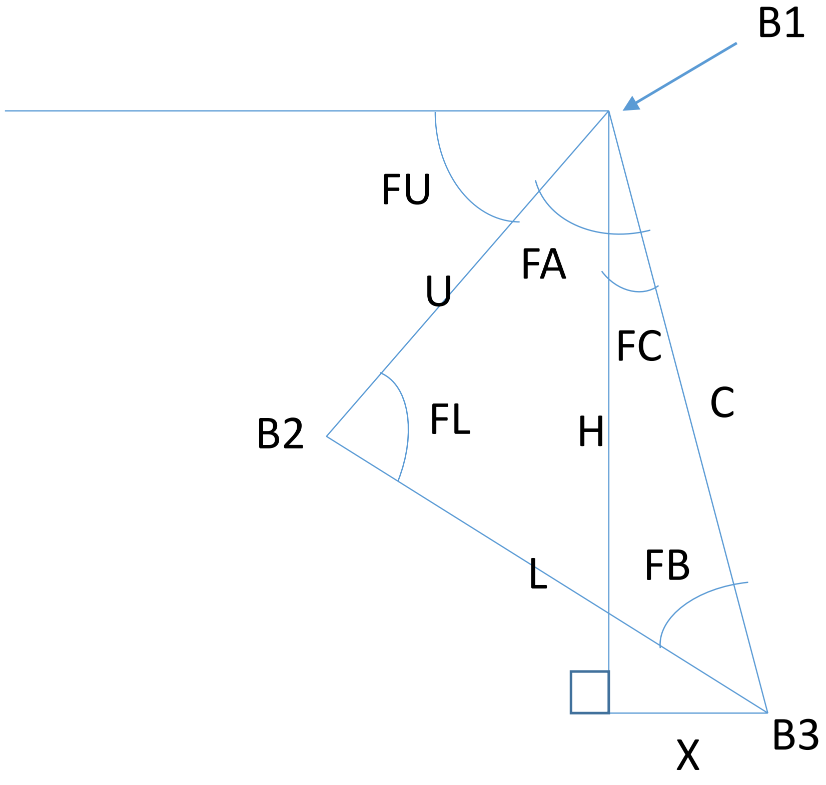
S=4000
D=6980
dx = 0 for starting position
X=S-D/2+dx = 510
H=5370
Length C= sqrt(H*H+X*X) = 5394
U =3550, and L=3160

Law of Cosines:
C*C = U*U + L*L -2*U*L*cos(BL) =
BL = acos((U*U+L*L-C*C)/(2*U*L))
BC = acos(H/C)
BA = acos((L*L+C*C-L*L)/(2*U*C))
BU=90-BA-BC

Think can use same math for front limbs…

Now for front where B3 can have larger x than B1

Will say X is positive when foot in front of shoulder



S=4000 (stride)
D=6980 (upper joint separation)
dx = 0 for starting position
X=S-D/2-dx = 510 (note –dx for front)
H=5370
Length C= sqrt(H*H+X*X) = 5394
U =3550, and L=3160

Law of Cosines:
C*C = U*U + L*L -2*U*L*cos(FL) =
FL = acos((U*U+L*L-C*C)/(2*U*L))
FC = acos(H/C)
FA = acos((C*C+U*U-L*L)/(2*U*C))
FU=90-FA+FC (note +FC for front)

Just sign changes in equations for X and FU

Appears that front and back angles would be the same if S==D