Hexagonal Drive Base and Bumpers

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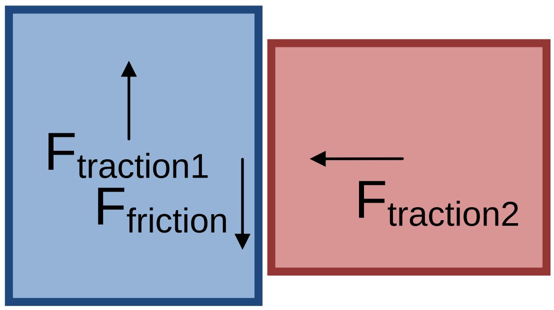
During the 2014 competition season, our robot's biggest weakness was its susceptibility to being "T-boned", or being pinned from the side by another robot by friction between the bumpers.



$F_{friction} = \mu_s F_{traction2}$

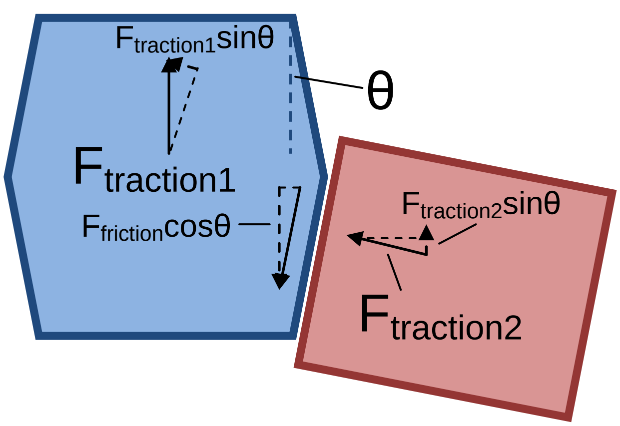
$F_{traction1} = F_{friction}$

So the robot cannot escape.

There are two factors that could reduce the friction prevent the robot's movement, the angle of effect of the frictional force, and the coefficient of friction between the bumpers.

Frame Geometry

By changing the angle of the sides of the frame, there are three factors that improve the situation. The friction force parallel and opposing the traction force would be reduced, because the friction is no longer parallel to the traction. The normal force between the bumpers is also reduced, because there is a component of the traction pulling away from the contact by the other robot. Some of the pushing force from the pinning robot would also add to the forward force of our robot, because the robot is no longer pushing perpendicularly.



$F_{normal} = F_{traction2} - F_{traction1}\sin\theta$

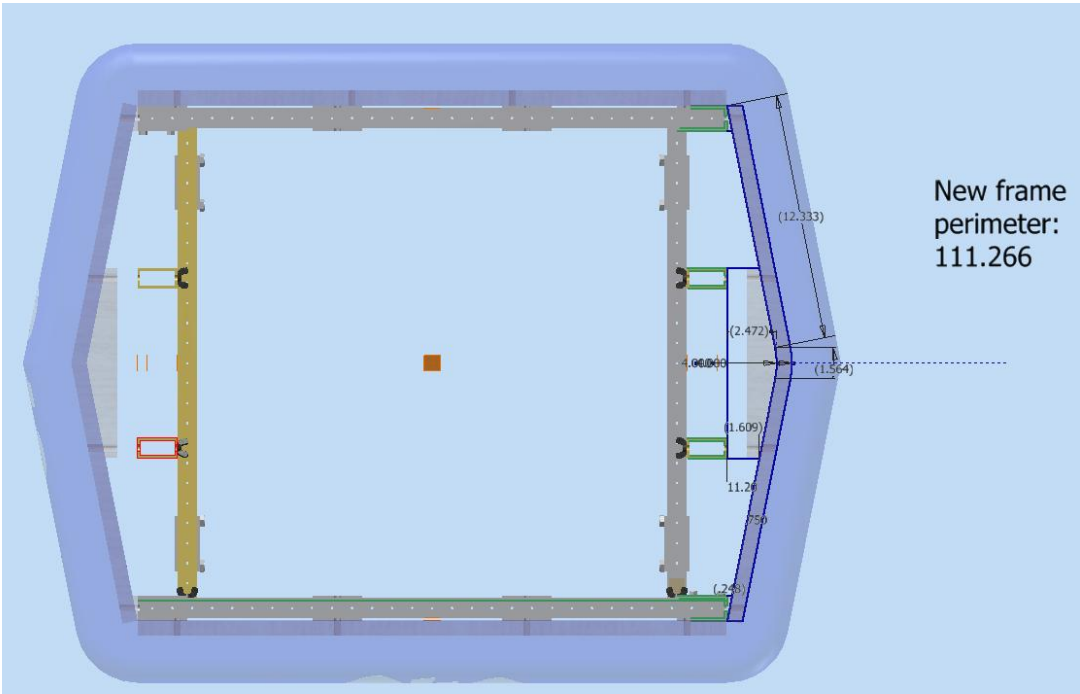
$F_{friction} = \mu_s F_{normal} = \mu_s(F_{traction2} - F_{traction1}\sin\theta)$

$F_{total} = F_{traction1} + F_{traction2}\sin\theta - F_{friction}\cos\theta$

$= F_{traction1} + F_{traction2}\sin\theta - \mu_s(F_{traction2} - F_{traction1}\sin\theta)\cos\theta$

As θ increases, F_{total} increases, making it easier for the robot to escape.

Using Autodesk Inventor CAD, I found how much angle I could add to our current frame geometry without exceeding the frame perimeter limit of 112 inches.



The maximum angle turned out to be around 11.7 degrees, which gave our robot 104% of its original traction force. This meant that any robot T-boning us would not only have no effect, but the other robot would actually be helping us drive away!

Low-friction Fabric

Another way to reduce friction was by changing the material of the fabric covering our bumpers. Doing some research, I found that sail cloth had a very low coefficient of friction. Performing a static friction test comparing the original material with the new sail cloth, I found that the coefficient of friction with the sail cloth was 3 times lower than the original. The coefficient of the original fabric with itself was 0.63, while the coefficient of the sail cloth with the original fabric was 0.21.

Testing the new bumpers, it was nearly impossible to tell when another robot was attempting to pin us, because there was no visible effect at all. The results of this modification were impressive.