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What Gear Ratio Are You Using For Hanging // Weight?

self.FTC

submitted 2 months ago* (last edited 2 months ago) by **Arctic_Wind**

FTC 6112 Wolfbyte

Hey guys,

What gear ratio are you guys using for your hanging system, and how much does your robot weigh?

Is there an easy way to solve what ratio you should use mathematically? Or is it more of a "safe bet" sort of thing?

Our robot is about 35 pounds, but we're looking into also supporting another robot to hang. How does 9:1 gear ratio sound?

Thanks! FTC 6112 Wolfbyte Alaska

P.S. If you're wondering what some others are doing too, I posted this topic on the FTC Forum as well.

FTC Forum Thread: What Gear Ratio Are You Using For Hanging // Weight?

7 comments

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[–] **Oriek** 6376 2 points 2 months ago

We're using a rack and pinion system with a... well I don't know the gear ratio but it's the small textrix gear to the medium one. Works super well.

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[–] **Dastyruck** 4278 2 points 2 months ago

We are using an arm to hang, so a large part of deciding our gear ratio was using torque calculations to figure out how much torque we would need in order to raise our robot. I'll spare you the complexities of calculating this but I can say that our arm is geared 7.6:1 and the arm hooks onto the bar about 17 inches from the rotational axis. We weigh about 30 pounds and use two tetrix motors to lift ourselves.

9:1 with two tetrix motors should be more than enough to lift a 35 pound robot, depending on your method of hanging from the bar. If you are using an arm, the further away your "hook" is from the rotational axis, the more torque required, thus the higher the reduction you will need.

If you post more specifics, I would be happy to help you figure out an optimal solution.

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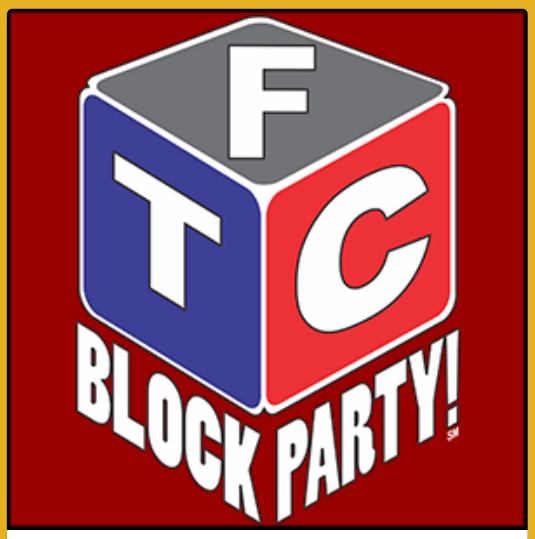
[–] **Arctic_Wind** FTC 6112 Wolfbyte [S] 1 point 2 months ago

The current plan is to use a "grappling hook," with the length of the line being 28 inches (though this could be moved to the second level, so could be 16 inches). We were thinking about using the tetrix worm gears, which have options of 4:1, 10:1, 20:1. We ideally would like to use 1 motor here; using 2 would be rather costly.

The idea is to have an arm which would have a fulcrum length of about 5-6 inches. It would



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e.g. *mozrila FTC 3415*

portrude a "second bar" for another robot to hang on. Ideally again 1 motor used here, and we're looking into worm gears again for this.

If the arm were supporting another robot, would the line also take some of the stress? Would we need to gear for about 70 some pounds on our line? As for each individually, would the 10:1 worm gears work? We appreciate any help you can give!

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[–] **Dastyruck** 4278 1 point 2 months ago

From what it sounds like, you would like to first hang yourselves using a grappling hook method using a worm gear and then a second arm would then be used to grab and then lift another robot off of the ground.

If this is the case, your line would indeed need to be able to handle the force of two robots statically. The worm gear used for the first stage would also need to not back drive under the stress of two robots. Though, neither stage would need to pull with the force required to lift two robots.

Starting with the first stage, the grappling hook, the amount of force the "winch" system will have to pull with is going to be the weight of your robot, in this case 35 lbs. The torque that a tetrix motor can produce at stall current is 325 Oz - in. The force that the winch system pulls is F = T / (r * sin(A)). In this case, the angle of lever arm will always be 90 degrees, which simplifies the expression to F = T / r where F is the force, T is the torque, and r is the radius of the axle that your winch cable is wrapped around. Since our torque is given in Oz-in, we want to use ounces for the force and inches for the radius. Converting our robot weight of 35 pounds into ounces gives us a force required of 560 ounces. If we used no added gearing, our formula would be 560 oz = 325 Oz-in / r. Which solves to r = .58 inches. If you move up to the 10:1 worm gear, the effective torque would be multiplied by 10. Which would make the formula 560 oz = 3250 oz-in / r. Which solves to r = 5.8 inches. So, if you choose an axle for your winch smaller than this, you will be able to lift yourself. I would stay on the side of caution and use something smaller than this, such as a 1.5" radius axle. The larger the axle, the faster you will go up.

For the next part, you have already said that your lever arm will be 5-6 inches. Staying on the side of caution, we should say that it is at 6 inches in radius. The force required to lift is again 560 ounces if the robot is of similar weight. Though, this time, the formula does not simplify out as the angle of the lever arm will change as the arm is rotated upwards to lift the robot off of the ground. Thus, F = T / (r * sin(A)). Solving this equation for torque, we get T = r*sin(A)*F. As the arm moves towards 90 degrees, or parallel to the ground, the torque required increases to its maximum. So, if we set the angle equal to 90 again, we are left with T = r*F. Since our radius is 6 inches and our force is 560 ounces, we find that we need a maximum torque of 3360 Oz-in. With the 10:1 worm gear ratio, we only get 3250 Oz-in of torque when the motors stall. So, increasing this to the 20:1 would be the best way to go if you wanted to use one of the worm gear options.

I am unsure of how much force is required to make the worm gears back drive or if they can even hold up to that amount of force on them. For a line that would most likely be able to hold up to 70 pounds of tension, I recommend a modern bow string material. We used this last year for our forklift cables. It has the benefit of being very strong while also being very thin, if you need it to hold more, braiding it is very easy to do and will give quite a bit more strength.

If you have any questions or want me to clarify anything, don't hesitate to ask.

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[–] **Arctic_Wind** FTC 6112 Wolfbyte [S] 1 point 2 months ago

Geez thanks for all the help on that! Shoutout to Team 4278.

As for our secondary lever arm, it is the last thing we are really looking into but we could also shorten the length of it to perhaps 3 or 4 inches.

The first ideal situation would be to hopefully use our grappling hook to hook, then move away from the hanging bar – give another robot space to get hold of the bar – and then come back and have both robots lift on their own simultaneously (brushing up against each other would prevent swinging). Sort of a concept that I've seen work on Youtube, not particularly sure whether it's consistent.

Thanks also for the tip on the bow string!

e.g. *Anton338 FTC 3415 (Alum)*

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[–] limellipsis FTC 5421 1 point 2 months ago

One word of warning about a grappling hook: you can't make your robot throw it. It's illegal for the robot to launch pieces of itself (as the GDC ruled here). A team got called out on it at our qualifier, and had to take their assembly off- don't let that be you!

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[–] tmbrudy 1 point 1 month ago

I use JVNs mechanism calculator for this kind of stuff:
http://www.chiefdelphi.com/media/papers/2755?langid=2

It doesn't have the tetrix motors listed in the list but you can get the new and old motor spec sheets here: http://cheer4ftc.blogspot.com/p/motors.html

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