Tracking Wheel Bracket Final Report

2021 "Make It Real" CAD Engineering Challenge

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I. Tracking Wheel Introduction

One of the most essential areas to success in VEX Robotics is a strong and consistent autonomous program. A major factor of this is accurately measuring the position of the robot as it moves, most commonly achieved through the use of optical shaft encoders. To further increase accuracy, many teams use dedicated tracking wheels: separate wheel and encoder assemblies designed to measure the distance traveled by a robot (Figure A). These allow for more precise sensor values as they are not affected by powered wheel slippage and their direct connection to a wheel reduces error through gearing. These elements are especially critical in advanced position tracking and odometry programs.

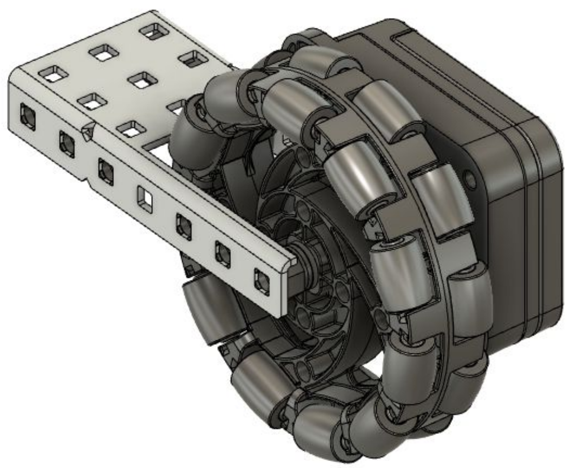

Figure A: CAD design of my team's current tracking wheel assembly

II. Current Design Problems

Although there are many designs for constructing tracking wheels, the majority involve a wheel supported by a c-channel with the center section removed (Fig. B). One of the most significant problems with such designs is the strength. With the center portion removed, the c-channel is reduced to only the sides, which can be easily bent and deformed. Additionally, this design provides only one mounting point for the shaft encoder, which can easily become misaligned creating high amounts of friction. Both of these issues cause problems in making robust and consistent tracking wheel assemblies. Additionally, the width of the metal causes the tracking wheels to be larger than necessary. When attempting to create a compact robot or add tracking wheels to an existing design, the large profile makes this much more difficult. Also of importance is the difficulty in constructing tracking wheel supports. Cutting the c-channel to remove the center requires precision cuts that can realistically only be made by advanced tools such as a bandsaw to which many teams may not have access. Correspondingly this greatly impedes many teams' abilities to incorporate more advanced and consistent programming.

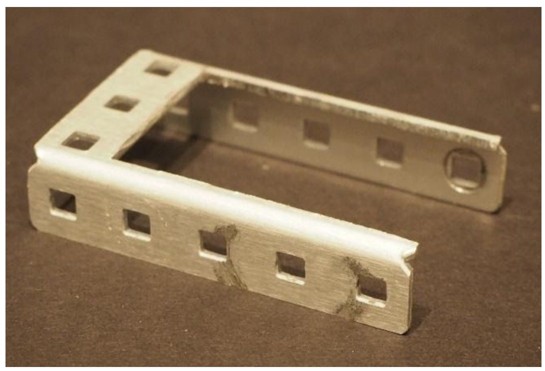

Figure B: Cut three wide c-channel used to construct a tracking wheel.

III. Solution: Tracking Wheel Brackets

As a high quality solution for tracking wheel assemblies, I have designed custom tracking wheel brackets (Fig. C and D). These brackets replace the metal in a traditional tracking wheel assembly, effectively eliminating many of the previous issues with the design. My design involves wider sides (approximately twice as thick as c-channel) which are much more resistant to bending. The brackets have three mounting holes to improve the mounting of the sensor and eliminate any misalignment. Most prominently, the custom brackets minimize wasted space in the assembly, making it essentially as small as reasonably possible. Using the brackets, the tracking wheel assembly is 3-4 mm thinner than the most common design using a cut 3 wide c-channel (Fig. E). They also eliminate the need to precisely cut metal making assembly more efficient and therefore more widely accessible.

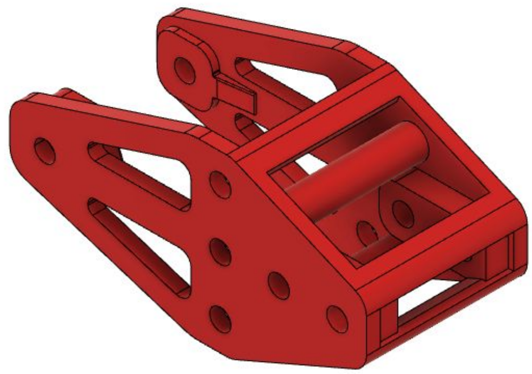

Figure C: Bracket in CAD

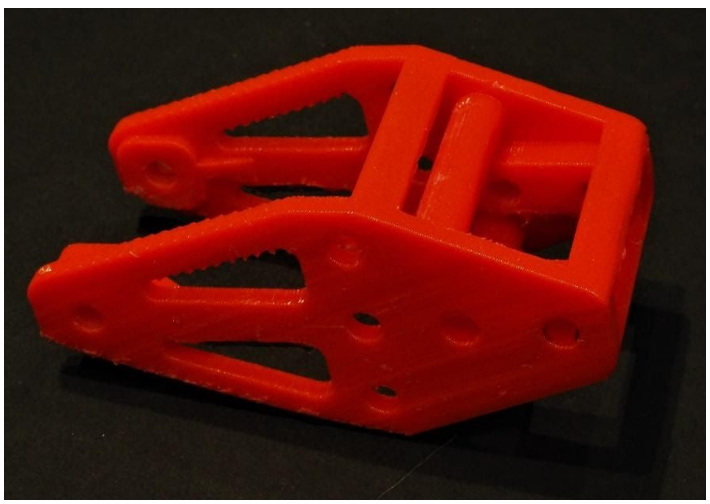

Figure D: 3D Printed Bracket - approximately 27 grams

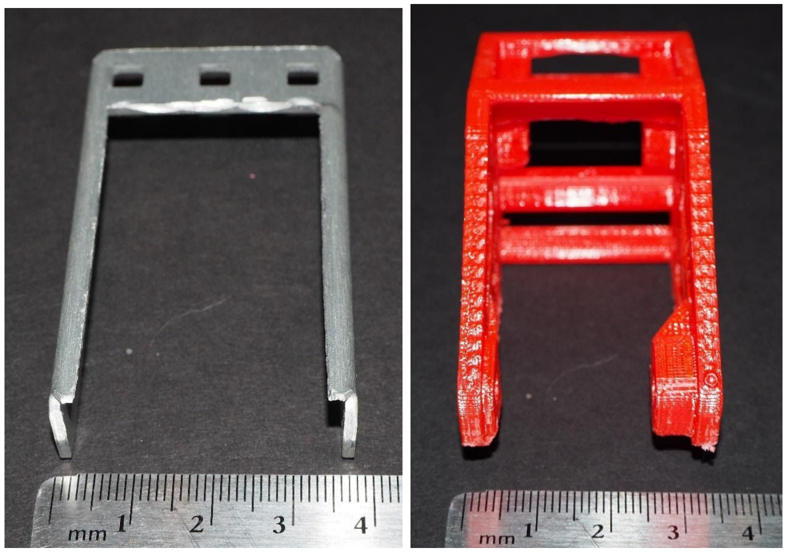

Figure E: Tracking wheel widths: cut c-channel (left) and 3d printed bracket (right)

IV. Usage and Application

The tracking wheel brackets eliminate the need for hardware such as bearing blocks and spacers, as bearings are built into the design and the interior width is designed without the need for additional spacers. The tracking wheel bracket is specifically designed to work with a VEX 3.25-inch omni-wheel and a standard shaft collar mounted on a 2-inch axle (Fig. F). The axle directly inserts into the encoder attached to the outside. There are also a number of cross supports in the back; the cylindrical supports serve the dual purpose of also providing an attachment point for rubber bands to tension the assembly down. There are additional holes in the back for screws to attach the assembly onto the robot on a rotating joint (Fig. F).

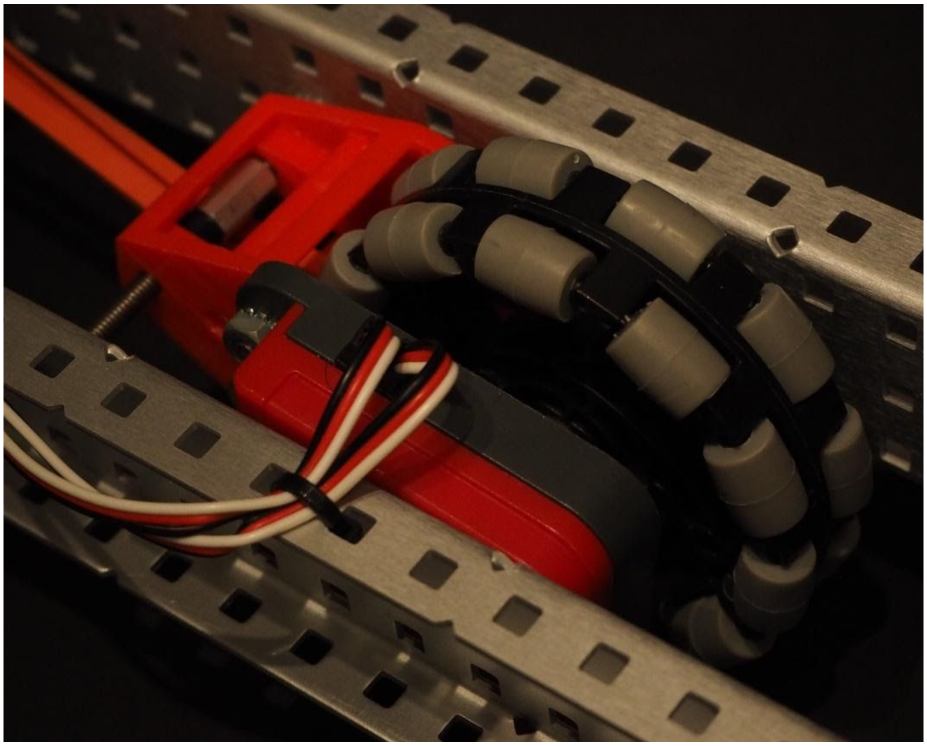

Figure F: Mounted tracking wheel assembly

V. CAD Modeling Program and Method

To design the brackets, I used Autodesk Fusion 360. To start, I used a previously designed model of a tracking wheel assembly using the standard c-channel design. I then drew a sketch on one side, allowing accurate placement of the attachment and axle holes in line with VEX spacings. Next I extruded this sketch to be 3 mm thick to form a wall, which I mirrored to create the other side. I then drew another sketch on this body for the side profile of the cross supports, which I then extruded to the desired length. By using a pair of calipers and measuring the required room to fit a wheel, I extruded these supports to the ideal length to create a bracket that has the least width possible. Similarly, I drew another sketch on the front to form the integrated bearing pieces, which I again extruded to the correct length by using calipers and measuring the width of a wheel and shaft collar. Last by using the combine feature I formed all of the bodies into a single component, completing the bracket. After 3D printing several designs, I made a number of minor spacing adjustments leading to the final design.

VI. Project Conclusion

This project has had a positive impact on my 3D design and printing skills. I improved my abilities in designing custom parts in Fusion 360 and learned to more efficiently develop custom parts with specific constraints. I also learned how to animate parts within the program to create a video. In the future on my current team, designing objects in Fusion 360 and other CAD programs will help me develop a robot design virtually and reduce building problems. In addition, I hope to continue VEX in the future on a VEXU team, and the CAD skills that I am developing now will be invaluable when 3D printed components are legal. My experience and familiarity with these computer programs will be very helpful in my future career path in engineering, where CAD programs are used frequently to solve real world problems. Therefore, this challenge has not only furthered my skills in CAD programs, but will also prove to be invaluable for my future interests and career goals.