AUTODESK.

Make It Real CAD Engineering Challenge

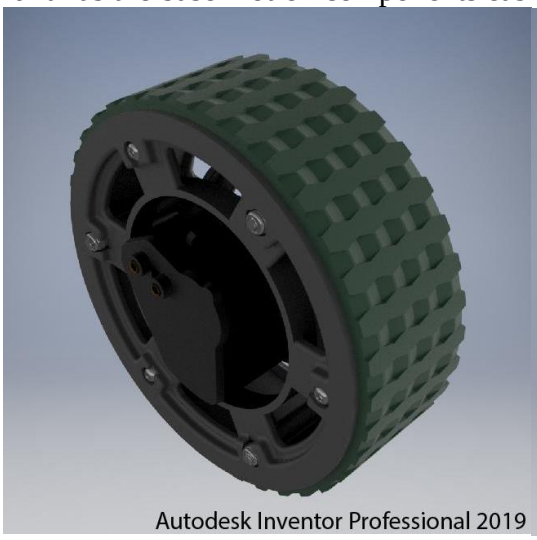
2018-2019

Introduction

Motion is the most fundamental concept for any VEX Robotics Design, a competition where a robot must move in order to win. Moving either for obstacle avoidance against various opponents or adjusting a robotic arm to flip or carry an object to its desired location. Our design focused on the robot base motion. In order to move a robot from point A to point B, teams almost always take a motor, wheel, and a shaft to hold it all together to the frame or chassis. If the competitors want to vary the speed or torque, a transmission system may be necessary to accomplish the design requirement. The complete assembly can occupy significant space, resulting in a less space for other important components. For this reason, we aimed to design a compact *V5 Smart In-Wheel Motor*, which includes the previously mentioned motion parts, that can perform equivalent motion using a considerably less space, allowing enough space for necessary components and reduce the overall size of the robot.

Design

In previous years, the robot motion assembly took up plenty of space mostly because the encoder was a separate component. VEX simplified many competitors' designs by adding to the market the powerful V5 Smart Motor that can read main shaft movement with an integrated encoder and can transmit variable amounts of torque with a replaceable gear cartridge system. We wanted to simplify it even further with our *V5 Smart In-Wheel Motor* and integrate every motion component into one compact design while also being able to adjust the output speed of the wheel, using the V5 Smart Motor's cartridges to drive the wheel. The design involves taking apart the original V5 Smart Motor, rearranging parts such as gears, DC motor, cartridge, and encoder board to fit inside a smaller 3D-printed hub that will be fixed in the center of a VEX Pro 6" traction wheel. This wheel was chosen for its accessibility to fit the in-wheel motor, with minor alteration to the wheel plates. Also avoiding designing new custom wheels gives us more time to work on the main design challenges. The printed in-wheel motor is fixed to an available fixed axis on the robot, preventing the motor from rotating while allowing the wheel itself to rotate freely. It is only a matter of placing four of these customized wheels on fixed axes on the robot and it has the base motion components easily installed.

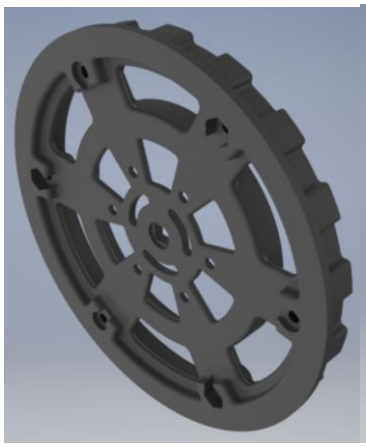


Complete Design Assembly

In-Wheel Motor

The 6” Traction Wheel was modified by making a 3.375” clear cylinder in the back plate to make room for the in-wheel motor, and an interface for the motor and the wheel was design for the front plate. Both modified Plates can be 3D printed and are compatible with the standard inner plates of the traction wheel.

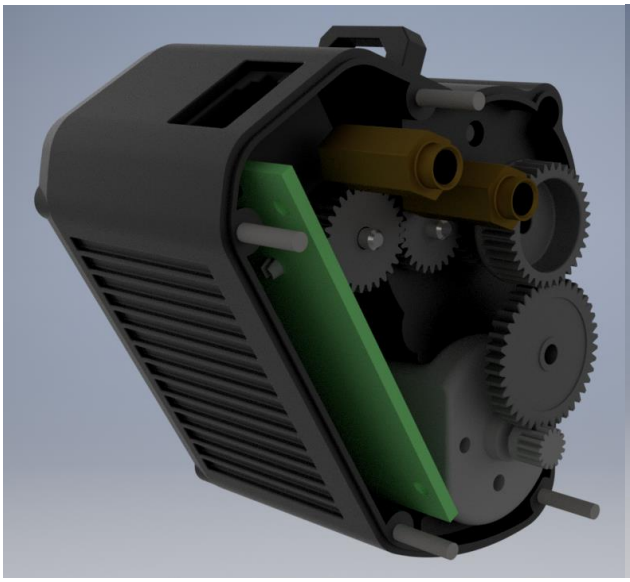
Original Wheel



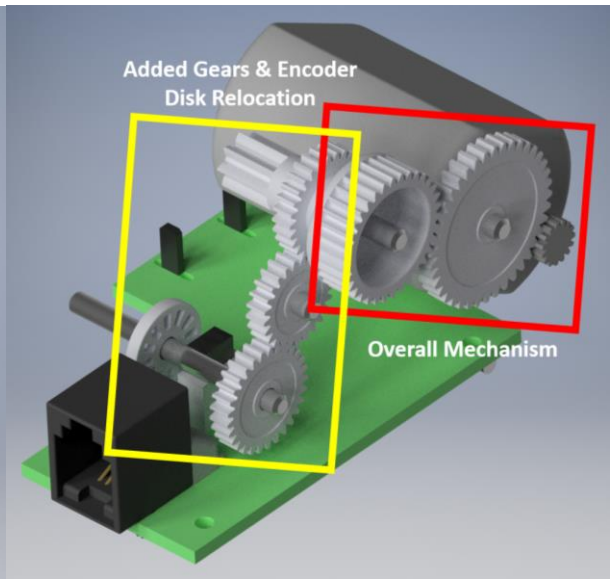
Costume Front Plate

Costume Back Plate

In the in-wheel motor some gears were added, and the encoder disk was resized to accommodate the design inside the 3.375” clear cylinder in the wheel. This will result in a false reading by the encoder, which could be compared to the original motor to calibrate it. The overall mechanism was not change, maintaining the same ration as the original motor. This way the motor still has the same torque and speed capacities as the original V5 Smart Motor.

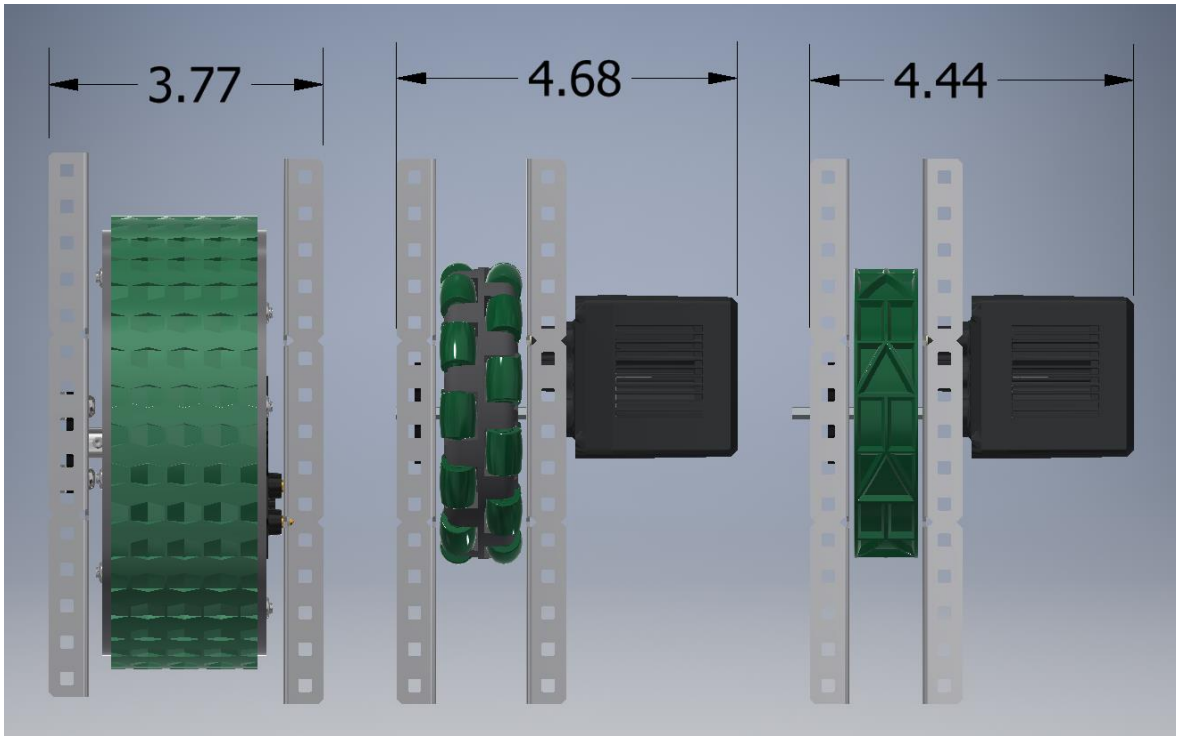


Inside of the Hub (with case)



Inside of the Hub (no case)

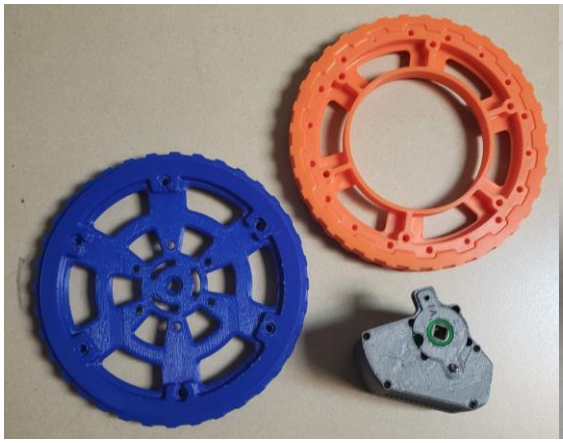
Comparing a standard assembly, the new wheel assembly occupies a 3.77” while old assemblies with more common wheels like the 4 in omni-wheel and the 4 in traction-wheel take 4.68” and 4.44”, respectively.



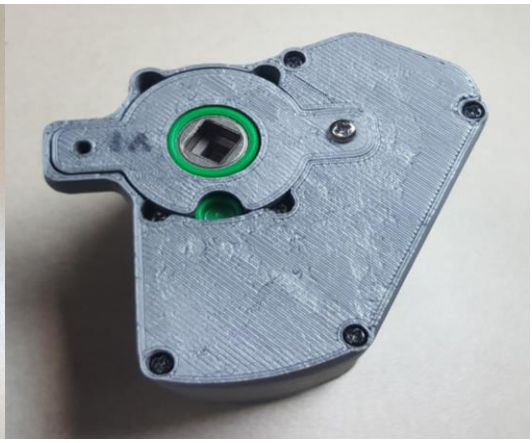
Wheel Mounting Measurements (measurements in inches)

These components were sketched using Autodesk Inventor Professional 2019 from the start of the process. Inventor was used to take advantage of the available library of VEX components in the software, along with additional models downloaded from the official VEX Robotics website, to simplify both the visualization of the materials available and the assembly process. Since it offers more advanced features than Fusion 360, the workload was divided evenly among each member to model and edit their corresponding part and the software allowed great ease to assemble the product. Some V5 components, such as the encoder board, had to be measured by hand before sketching it into the software. The motor hub was the only component drawn from scratch, while the rest were either edited from exiting sketches or oriented adequately.

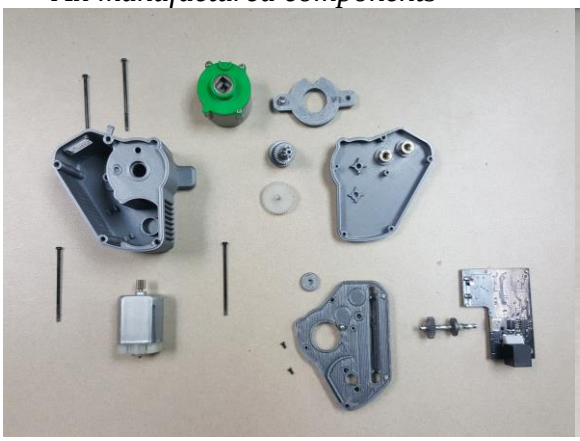
Manufactured Parts



All manufactured components



In-Wheel Motor



In-Wheel Motor (disassembled)

Gears closeup

Full assembly (front)

Full assembly (back)

All parts were manufactured with PLA in a Prusa i3 MK3 printer. The pieces are sturdy and functional, but some inner components of the motor case might be better manufactured with another method to prevent failure by ware.

Conclusion

This project was a great opportunity for engineering students with similar interests to work together to come up with a design that could benefit competitors on the long run. The idea was to put together something that would ultimately be useful and simple to use for every user, while making it challenging to design and demonstrate the engineering hours that were dedicated, due to the level of difficulty that was established. In terms of technical development of the component, the design team learned to be familiarized with Inventor as a practical CAD software to implement into our skillset as engineers. Also, we learned how to apply the iteration method in both design and manufacturing processes to optimize the functionality of the component and reduce overall material costs, respectively. Lastly, 3D-printing small-load gears is viable for prototyping in future designs. Teamwork was essential to make this project come to life, keeping constant communication among the members of our VEX Robotics team to receive some feedback and learn from different perspectives for approaching the problem and determine the best solution. It is important for engineers to learn to drive all phases of the product development cycle from conceptualizing ideas through sketching, creating models, developing engineering designs, supporting production, and rolling out new and improved products, as this project allowed the team to carry out.