Novel Drive System for Spherical Robots

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EXTENDED ABSTRACT

The purpose of this project was to design a new drive assembly for spherical robots. As applications of robotics expand, the need for innovative and improved methods of drive systems is needed. One type of robot with a particularly challenging drive system is a spherical robot in which the entirety of the robot is inside of a spherical shell. Currently two methods exist for driving these robots. The first has a one-directional drive inside the shell. To change the direction, the drive is rotated relative to the spherical shell. The second has three orthogonal axes inside the shell that can exert torque. By combining the torques, acceleration of the robot in any direction is achieved. However both of these methods present disadvantages. The first method cannot instantaneously accelerate in any direction. The second method never has a permanent interior orientation which is needed for cameras or any sensors requiring a consistent. The design challenge was to design a drive system for spherical robots that could successfully address with each of these difficulties.

After considering several ideas, the design selected has two wheels that have axes of rotation that are parallel to the horizontal and are perpendicular to each other. These wheels are both tangent to a rubber sphere which is rotated by turning the wheels. By changing the direction and speeds of each wheel, the rubber sphere can be rotated in any direction. This rubber sphere is held by bearings on the bottom of the inside of the spherical shell. By acting as an omni-directional gear, the rubber sphere turns the shell. This allows the robot to accelerate in any direction by simply powering the two different drive trains as needed. This drive system also preserves a direction by keeping a horizontal plane inside the robot. This allows for sensors and cameras to be effectively used inside the robot.

To evaluate and demonstrate the capabilities of this design, a prototype of the drive system was developed. The prototype excluded the shell and instead was mounted on a T-shaped frame on a table. The rubber sphere translated a sheet of poster board across the table rather than spinning a shell. The two wheels were powered by individual motors. These motors were controlled by a microcontroller. The speed and direction of the motors could be manipulated with the software.

The prototype design was successfully built. The principle behind the design was proven to work. The wheels did not interfere with each other. The combination of both motors was also shown to produce motion that was a composite of the two directions. However, while the principle was shown to work, two difficulties presented themselves. First the motors were barely strong enough to drive the rubber sphere and, the direction of motion could not be finely controlled. Stronger motors should solve this problem. The second difficulty was poor traction due to alignment. This issue could be addressed with higher quality parts and finer construction specifications. The next step in the evaluation of this drive system is to compact the drive train and install it in a spherical shell.