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DESIGN AND MANUFACTURING OF MECANUM WHEEL FOR OMNIDIRECTIONAL ROBOT

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ABSTRACT

The present automobile industries need execution of industrial robots due to standard in mass and batch size production of the vehicle. Design of Omnidirectional vehicles is now a traditional way in automobiles sectors. The operating advantage of this kind of vehicle is on any kind of surface such as a rough, smooth, flat and curved surface. A vehicle has the potential to get omnidirectional, if it operated on mecanum wheel. By providing the omnidirectional ability vehicle have moving flexibility that such type of vehicle can work in any internal and external application. In present paper design and manufacturing of mecanum wheel for omnidirection vehicle has been presented. Different design and fabrication steps are discussed. The proposed model of mecanum wheel is used for transportation purpose. The cost was the major fraction for manufacturing of wheel so in present work Teflon material I used in the manufacturing of roller.

KEYWORDS: Omni-Directional Mobile Robot, Mecanum Wheel & Autonomous System

Original Article

INTRODUCTION

The mecanum wheel was originated by Bengt in 1975 from Sweden. It I based on the theory that center wheel is placed in between the number of rollers around its periphery at an angle. A normal force is translated in the direction of the wheel by the peripheral roller. The resultant force is developed by the individual elements of the roller, which in turn move freely without changing the direction of the wheel. In the present automation world, the demand for industrial robotsare increasing. Many processes service industries are using mobile or movable robots for transmitting of raw material of finished product from one place to another place. It is observed that uses of industrial robots are common due to the reason of saving in time and money in transportation. The advantage of the omnidirectional robot is that it can move independently as well as work in three degrees of freedom. An omnidirectional vehicle can increase its movability in an effective manner. Although, it is a challenging task to apply mobile robots in many industrial sectors like cement industry, automobile industry, aerospace industry and defiance organization. These industry required high skills and high movability at the same time. Manufacturing of different parts in such type of industries requires high labor cost as well as complexibility in operation. They designed the mecanum wheel with the set of standard formulas. The wheels were designed for educational purposes and as a prototype for a possible larger model [1]. They developed an omnidirectional robot o which consists of nine rollers. The robot is operated using direct current motors and they are directly coupled to the chassis [2]. This paper proposed an improved design for a mecanum wheel for Omni-directional robots. This design improved the efficiency of mobile robots by reducing frictional forces and thereby improving performance theoretically. Paper theorized that surface plays an important part in the creation of force vectors of individual wheels [3]. The paper shows results for four-wheeled Omni-drive transport systems and certain ranges for trajectories and starting conditions, a curved path can be traversed faster than a straight-line path [4]. This paper shows the results of an electrical design of a robot that uses mecanum wheels. It shows the different variations in its tests [5]. The paper was an overview of the design of Omni-directional mobile robot using mecanum wheel [6]. The main advantage of this type of wheel was represented by the omnidirectional property that it provided, allowing extreme maneuvrability and mobility in congested environments [7]. In this paper, they introduced the new design of the Omni-directional mobile robot with mecanum wheel to overcome the weak points of their previous robots [8].

VARIOUS METHODS USED

For the manufacturing of mecanum wheel following standard method is used. Increasing the Wheel Diameter during the initial design phase according to the contact of the minimum angle of arc we can avoid the bot getting caught in a circular terrain. As the diameter increases the angle of contact remains optimum for forward motion. Designing and using proper hubs during designing phase would eliminate the lateral vibrations produced by the motion of the roller in contact, by providing a firm grip of wheels to chassis with the substantial amount of force would thus keep them in negligible range. Optimum design of point of contact of rollers, solutions obtained by Model Analysis will provide accurate data for minimum loss of kinetic energy. Different simulation with different materials, length of the roller, a width of wheel and diameter of the wheel would thus provide a proper solution, saving time and money. Economic constraints does not allow these individual prototypes to be made.

DESIGN PROCEDURE

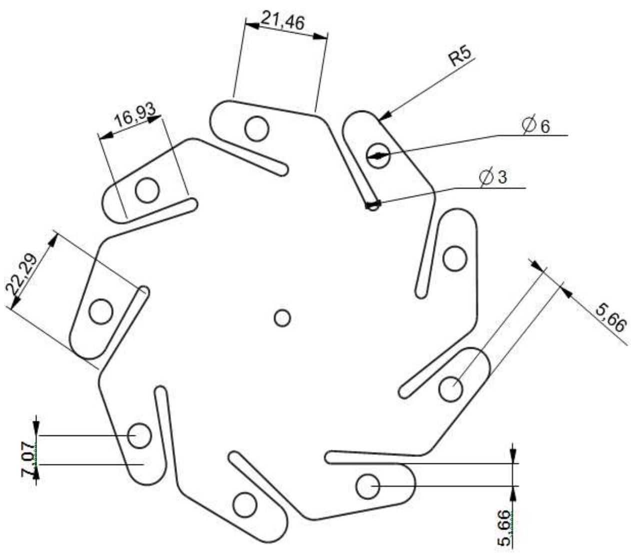

Figure 1: Dimensions of the Rim

Before manufacturing any components essential step is designed its working parts. Following steps describe the procedure of different components. For Design of Rims, First selecting the plane and drawing a2D sketch of the rim (Figure 1). Then extruding the 2d surface into the 3d model with 1mm thickness. Using the pattern feature at the center axis of the rim at 40 degrees of angle to create 9 teeth at the periphery of the rim. After that bending of the teeth at the periphery is done by extrude cut at 45 degrees of angle. Then holes of 6mm are made as shown in the 2D Figure 2. For Design of Rollers, First selecting the plane and drawing a 2D sketch of the roller cross-section above the central axis, with the maximum diameter of 20mm in between and minimum diameter of 16mm at the end surface of the roller. Then selecting that axis and performing revolve action on the center line. Then assembling studs of 6mm diameter with the roller as shown in Figure 2.

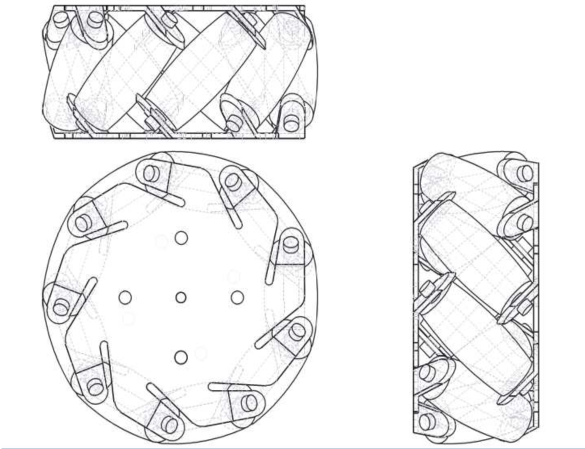

Figure 2: Wireframe Figure of Mecanum Wheels

MODELING OF MECANUM WHEELS

First opening **dot asm** file in PRO-E/PTC Creo parametric 2.0 and selecting the rim as default reference. Then the second rim is selected and assembled at the top of the shaft passing through the center of the default rim. After that calling the assembled rollers and giving it constraints like coincides the surface of the studs with the inner surface of the hole at the tooth of the rim. After that giving distance constraint of 2mm between the upper surface of the studs and a bent surface of the rim**.** Then applying pattern feature to the roller assembly at the center axis of the default rim at 40 degrees of angle as shown in Figure 3, 4, 5.

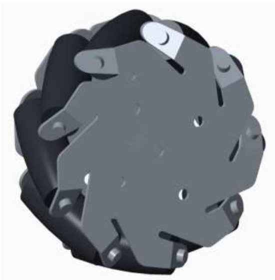

Figure 3: Three Dimensional View of Mecanum Wheel

Figure 4: Front View of Mecanum Wheel

Figure 5: Side View of Mecanum Wheel

DESIGN PARAMETERS

Number of Roller (n) = 9

Angle between axis of roller and driving axis (γ) =45^o

Diameter of Mecanum Wheel (D) =100 mm

Radius of Roller (R) at the center = 20 mm

Radius of Roller at the end=15 mm

Length of Roller (L_r) = 47mm, Width of the Mecanum wheel (L_w) = 50 mm

MANUFACTURING OF MECANUM WHEEL PARTS

Rollers are generally made of light materials. One can be used Teflon as it is light in weight and is one of the few polymers that can be manufactured on the CNC machines without unwanted deformation. Teflon, initially very smooth, tend to roughen over time, thus improving the grip of the wheel as it ages. The selection was based on two factors mainly the weight of the material and its ability to be machined. Teflon fulfilled both the criteria. For our wheels, one can required 8 feet length and 22 mm as diameter. Manufacturing of mecanum wheel consists of different parts like roller and rim. Following are the procedure for the fabrication of these parts. Machining of Teflon was done on CNC lathe machine. The final product goes various process, these are 1) Turning 2)Facing 3)Drilling 4)Radius Turning (Concave Profile) 5)Parting. It starts with the facing process which required reducing the length of the roller from 50 mm to 48 mm. Then turning tool was used to reduce the diameter of 22 mm to 20 mm. Then using radius turning operations one can achieve the required specifications of 20 mm diameter at the center and 15 mm diameter at its end. The drilling operation is used to drill a hole of 6 mm diameter for the attachment of studs. Lastly, parting process is used to remove the roller from the entire block of roller material. The figure shows the CNC code for manufacturing the roller.

Figure 6: FANUC Controller(O-T series) along with Page of Code

A Figure shows the comparison between the 3 D model and the actual fabricated roller.

Figure 7: Model of Roller

Figure 8: Actual Roller

The final look of the roller was achieved. Studs and washers were attached to them to allow them to be attached to the rims. Threading was done at the end, while at the center it was allowed to remain the same. Studs are at a length of 74 mm, washers are of 1mm thickness. Nuts are M6 and threading is done in accordance to it.

Figure 9: Actual Fabricated Mecanum Wheel

CONCLUSIONS

The present work describes the design and manufacturing process of mecanum wheel parts. The basic application of mecanum wheel is in an omnidirectional robot. In the present paper cost-effective design and manufacturing process was described. The fabricated wheel is used in robot application which further transforms the raw material and finished product from one place to another place. It is found that the present method for designing and fabrication was quite easy and save fabrication cost.

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