DESIGN AND DEVELOPMENT OF THREE OUTPUT EPICYCLIC GEAR SYSTEMS FOR A GRIPPER

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Abstract— The ability of an under-actuated hand to pick and place different objects is mainly determined by the mechanical design of the finger. The main objective of this project is to grasp an unknown shape of an object with when one finger is block, the remaining finger(s) should continue to move and study about effective grasping forces obtained on different configuration of gripper. Then designing a differential mechanism incorporating an epicyclic gear train. The mechanism used in such a system confirms the requirements of adaptively and compactness. A gear train having relative motion of axes is called planetary or epicyclic gear trains. In an epicyclic gear train system the axis of at least one of the gear moves relative to other. Epicyclic gears axially produce a three output system with compact shape. By using mathematical calculation, the speed and torque of a driven gear is calculated. Also calculate the grasping force of an finger.

Keywords—adaptively; epicyclic gear train; gripper;

I. INTRODUCTION

An increasing research interest in the robot endeffector is growing worldwide. There is an emerging industrial need to apply adaptive robotic hands to substitute humans in dangerous, laborious, or monotonous work. The principle of under-actuation in robotic hands can result in the reliably and easily grasping of the large variety of products. Here, an epicyclic gear train system the axis of at least one of the gear moves relative to other. In each output gear the differential mechanism is takes place for, when one or more fingers are blocked, the remaining finger(s) should continue to move. When all the fingers are blocked, the force should be well distributed among the fingers and it should be possible to apply large grasping forces while maintaining a stable grasp.

In under-actuated grasping system is used in this paper. Particularly the hydraulic system in the sense to be used in this paper. The gripper mechanism was constrain with kinematic calculations.

II. REQUIREMENT OF GRIPPER

Main obstacles to the automation of complex tasks involving in grasping of various object in an unstructured environment with lack of grasping tool. In many application, the manipulation of object and human hand is not more sufficient. However the simple gripper is not suitable for grasping an unstructured object, for that development of epicyclic gear system with help of differential mechanism the fine and compact gripper was designed for more effective graping. This hand can be operate the help hydraulic system.

III. UNDER-ACTUATION

Grippers are devices used with pick-and-place robotic systems to pick up or place an object on an assembly line, conveyor system, or other automated system. Fingered tooling—or jaws—is attached to the grippers to grip or hold the object.

They come in a variety of styles and powered designs. Three common types are parallel, three-finger, and angled designs. The most common are parallel designs, with two fingers that close on a work piece to grip it or open it out by creating pressure on the inside. Three-finger designs hold the work piece in the centre, and have three fingers offset by 120°. Finally, angled designs feature jaws that work at a variety of different angle openings. Here the hydraulic system is used for input source with different set pressure.

IV. DESIGN MODELING

Through the modeling software, the design was modeled based on the calculated dimension that was shown in fig 1. The working procedure of this concept was when the driven gear is rotate, and the pinion gear is rotate along the driven. Through pinion gear the power is transmitted to output driven gear. In driven shaft worms and worm gear are provided at left-hand thread on the worm, this is also known as single-enveloping type of worm gear. Here the rotary motion converted into linear motion. That was transmitted into gripper. When the gripper strike an object the output shaft blocked. Then the pinion gear was rotate around the output driver gear.

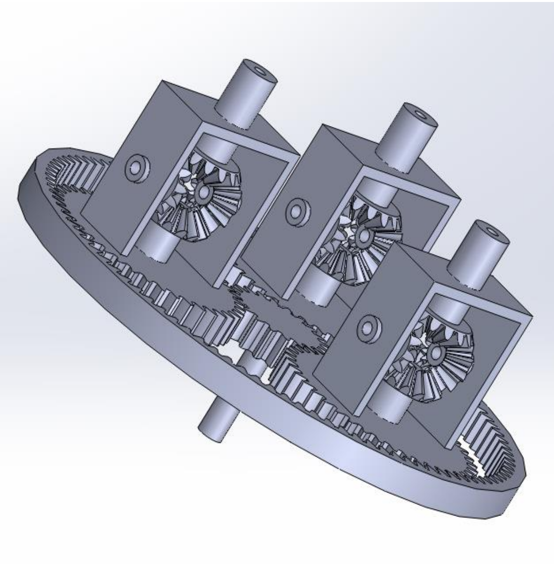

Fig 1; three output gear system

A. working

The input hydraulic pressure is given to hydraulic motor, it rotates with some specified rpm based on pressure applied. The driver gear(N1) transmitted power to driven gear(N2). In that driven gear, differential gear is mounted at each planetary gear. In that driven shaft one end is fixed with differential unit and other end is fixed with worm gear for convert rotary motion into linear motion. When the worm wheel rotates clockwise direction the finger moves forward motion(grasping an object), if the worm wheel rotates anticlockwise direction the finger moves backward motion(releasing the object)

From the kinematic calculation, for this experimental setup. When driver gear complete his 100 revolution per minute the worm wheel rotates 11.45˚and the linear displacement is 4.8mm.

B. finger configuration

The primary aim of the gripper mechanism is to convert input power into required motion and force to grasp and retain an object. Fig 2 represents the free body diagram of the proposed Four Bar Linkage Gripper from where Equation 1 has been deduced. This equation is suitable only for horizontal and vertical grasping of an object.

$$T = mg \cos\theta \,(L+L') \,/\, (2\mu r L) \qquad (1)$$

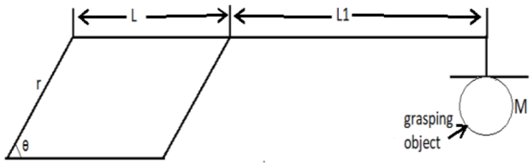

Fig 2; finger configuration

Variables in this equation are m, T, θ & μ

μ -> The frictional coefficient between the gripping surface and the object, μ, can be calculated experimentally using Sine bar.

m -> The mass of the gripped object, m, can be obtained experimentally using Digital Balance.

θ ->angle of crank radius movement in worm gear

T -> The torque required for gripping the object.

C. grasping force

the fingers are designed so that they are able to hold an object. The coefficient of friction between gripper and object is 0.6-0.71. this is done to underestimate the force required to hod an object. F is the force on each finger

$$F=M*g$$

Force required to grasp an object, $F=\mu*M*n*g$

V. RESULT AND DISCUSSION

From the above formula, the force, torque required for grasping the object to be calculated with three different mass. Based on experimental setup, the below values are calculated.

	Mass, kg	3kg	4kg	5kg
Finger 1	Angle, θ	45 °	45 °	45 °
	Torque, τ (N.mm)	44.7	59.7	74.6
	Force, F (N)	29.43	39.24	49.05
Finger 2	Angle, θ	50 °	50 °	50 °
	Torque, τ (N.mm)	40.7	54.2	67.8
	Force, F (N)	29.43	39.24	49.05
Finger 3	Angle, θ	55 °	55 °	55 °
	Torque, τ (N.mm)	36.3	48.4	60.5
	Force, F (N)	29.43	39.24	49.05

Based on finger angle the grasping torque is varies, but no change in grasping force because all fingers are in same geometrical configuration.

Fig 3; experimental setup of a gripper

Fig 4; when 2 fingers blocked with object and remaining 1 finger continue to move

Fig 5; three fingers blocked the grasping object.

CONCLUSION

From this study, a methodology was proposed for hydraulic motor. This mechanism has large scale application in space applications, industrial purposes and other complicated situations. Designing a one input three output differential mechanisms incorporating an epicyclic gear train and then analytical calculation for driven shaft. This system are their adaptively to hold any shape objects, suitable for any environmental condition. Here the experimental setup was slightly more weight, so its not suitable for robotic arm. In future scope fabricating the gripper in lite weight material and compress to more compact in size. And then grasping contact force are calculated through labview software for more accuracy.

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