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Designing And Development Of Two Finger Compound Gripper For Internal And External Gripping

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Abstract:

This paper provides a review of techniques and technology used in industrial grippers for External and internal gripping purposes. The scope of review is to cover methodologies in compound gripper, multifunctional gripping technologies, concentric gripping and two finger grippers used to pick and place cylindrical objects in industries. Paper also includes innovations made in gripping techniques and suggests improvements using innovative changes in existing grippers.

Keywords: *2 finger gripper, compound gripper, internal gripper, robotic gripper*

Subject Classification*: Internal and External Gripping Technique in Industrial Robotics.*

1.Introduction

The end-effector of an industrial robot is the most important device attached to its wrist (end of the robot arm). A robot without an end-effector is like a human being without a hand. One can really imagine the difficulties and problems a person has to endure without having a hand to manipulate or sense objects desirable and effectively. Similarly, the end-effector of a robot arm is the vital part that actually accomplishes a variety of manufacturing tasks by manipulating the objects or work pieces either by means of a gripping mechanism or a tooling device within the robot's workspace. It is usual that in a manufacturing environment, the robot is used to pick-and-place objects, assemble components, weld together two different parts, machine work pieces, paint bodies and structures etc. It is thus essential that the end-effector should be carefully and properly designed before it is implemented to accomplish the desired tasks effectively.

Development of a gripper which could be used for internal and external gripping of cylindrical objects. A gripper which could accomplish two different operations without change in the setup where otherwise two grippers would have required. One gripper could be used for gripping of hollow cylindrical objects from inside and as well as from outside or both at a time for providing firm grip in case of fragile objects.

Existing methodologies implemented for internal gripping makes use of vacuum or expanding rubber grips for internal holding of hollow objects. These grippers are only suitable for only internal kind of gripping. Whereas Mechanical grippers employed for external gripping purposes can only hold objects from outside. This isn't suitable in many cases especially if object isn't completely regular shape from outside or fragile in nature.

So, the solution to this is a two finger dual functioning compound gripper. The grippers which would have gripping surface from both rear and front side. This would help in using the same gripper fingers for different object handlings.

2. Multifunctional Gripper

Multifunctional gripper was developed to ease the work of assembly which consisted of mounting of rubber rolls on shafts. It is the task of the gripper to handle the shafts and rubber rolls by picking them up from the feeders and placing them on to specific fixtures on a work table.

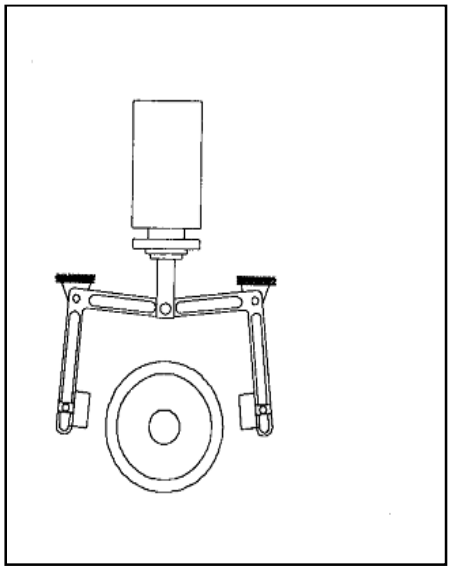

Figure 1: Conceptual Multifunctional Gripper Unit. [#10]

The most time-consuming operation is picking and placing the rubber rolls via the robot's gripper. The robot picks up rubber rolls one at a time. The largest number of rolls to be picked is four and hence the robot needs to repeat the same picking operation four times. An alternative solution would be to pick the rolls simultaneously which would considerably reduce the pick time up to four times the present rate.

A special type of multi-gripper (fixed to the end of the robot arm) has been developed. This gripper can hold more than a single roll at a time (in the design two, three or four rolls). In other words, the rolls can be grasped simultaneously. The number of rolls to be handled will depend on the programming of the robot itself. The other task that the gripper should perform is handling of shafts which come in different lengths and sizes. Thus a gripping mechanism to hold the shaft should also be appropriately designed.

The operation of the gripper related to the grasping of the rubber rolls is direct and simple. It utilizes the concept of a lever mechanism. A load derived from the magnetic pull of the solenoid's plunger is applied at the center of the unit causing the shorter end of the fingers to tilt upward. This force is transmitted to the other end of the fingers thereby producing a grip or 'close' action. Any components or work pieces placed in between the fingers will be firmly gripped.

There are six such units arranged in a single row and mounted on a light rectangular metal plate using screws. The proposed gripper consists of a number of individual units comprising a tubular solenoid, twin 'bell-crank' levers acting as the fingers, a pair of

clamps and attachments. The end of the solenoid's plunger is connected to the shorter end of the lever while the clamp is attached to the longer section of the lever. A pivot is located at the lever's 'meeting point'. The forces involved may be easily calculated using principle of mechanics as shown in the following section. The fingers are left' open' by switching off the electrical supply to the solenoid thereby returning the gripper to its original position.

The release of the rolls is accomplished by simply switching off the power source once the gripper has reached a suitable destination. The rolls drop automatically due to the effect of gravity when the fingers are opened.

The multi-gripper is a special feature of the assembly system. It is designed specifically in such a way that it can handle the rubber rolls simultaneously instead of handling them one at a time as does the conventional gripper on the present system. As a result, the pick operation of the rubber rolls is speeded up considerably.

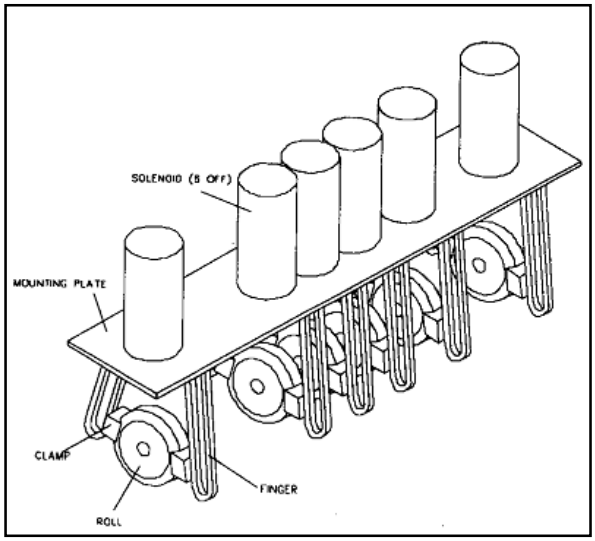

Figure 2: Complete Gripper Unit [#10]

3. Optimum Design Of Two Finger Gripper

The Gripper can be considered as component of automated manipulations since it interacts with the environment and particularly with the piece to be machined or manipulated so that the gripper gives a great contribution to a practical success of using an automated or robotized solution. Therefore, a good design of a gripper may be of fundamental importance.

The design of a gripper must take into account several aspects of the components and the system together with the peculiarities of a given application or a multi-task purpose.

Strong constraints for the gripping system can be considered lightness, small dimensions, rigidity, multi-task capability, simplicity and lack of maintenance. These design characteristics can be achieved by considering specific end-effectors or grippers.

Dimensional design of gripping mechanisms may have great influence on the capability D of a gripper, Fig.3, and on the grasping force, since the mechanism size may affect the grasp configuration and transmission characteristics of the device. These peculiarities can be considered well known when it is taken into account the great variety of mechanisms which have been used and are still used as Gripping Mechanism.

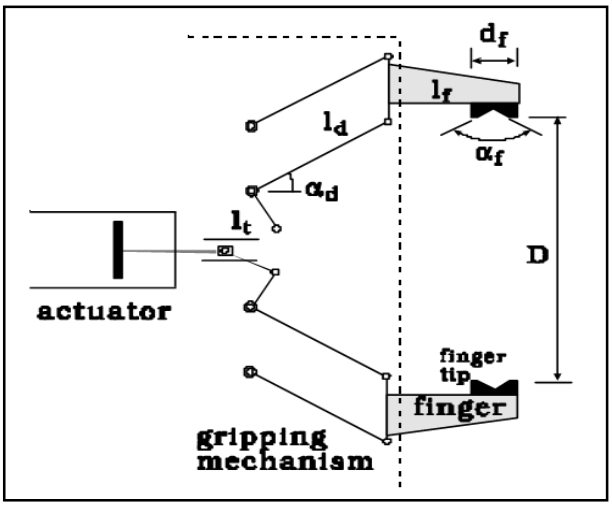

Figure 3: Mechanical components and design parameters of a two-finger gripper

Fig.3: shaped fingers; gripping mechanism; connecting transmissions; actuator.

The mechanical part of a two-finger gripper can be considered as composed by, Fig.2: - fingers and finger tips, which are the elements in contact with a grasped object, so that they perform the mechanics of grasp on the object itself;

- gripping mechanism, which is the transmission component between the actuator and the fingers
- Actuator, which is the power source for the grasping action of a gripper

It is a parallelogram linkage with sliders as bottom pairs, which is connected to the actuator through a pinion. Due to the mechanism symmetry, only the left half can be studied.

The grasping aim for a gripping mechanism has been formulated through a suitable performance index, named as Grasping Index, which may describe synthetically both kinematic and static characteristics for a proper grasp. The proposed formulation has

been useful for a numerical procedure which may make easily use of commercial software for solving the optimization problem. An interesting result of this paper can be recognized in the fact that it proposes a way to design mechanisms for grippers by taking into account the peculiarities of required performances in grasping actions.

Several kinds of pneumatic rubber actuators have been developed and reported with two or more internal chambers having symmetric cross section. Also their internal pressures are controlled independently through flexible tubes, which are connected to pressure control valves. Examples of them are Rubber gas actuator driven by hydrogen storage alloy [5], Flexible microactuator [6]-[7], Pneumatic wobble motor [8], Pneumatic soft actuator [9]. In the search for a simple soft robotic gripper design, a new technique altogether different from others yet versatile has been found and developed based on an asymmetric (eccentric) stretch type polymer tube actuator [10]-[11]. Pneumatic actuators made of elastic tubes based on our technique, however did not cite our research work in their references [12]. Instead of three internal chambers in a flexible actuator made of rubber or fiber-reinforced rubber [6], the proposed actuator not only has a single internal chamber but also simple, compact and easy to manufacture. The flexible actuator can be bent in any direction by just rotating it to the desired angle. Thus eliminating the usage of more number of control devices. The need for totally new approach to achieve flexibility or dexterousness similar to the human hand is felt. The applicability of asymmetric flexible hydraulic/pneumatic actuator to robotic grippers has not been investigated. Nevertheless, these actuators at least have potential for grippers or robots of the size of several millimeters to several centimeters because they have the advantages of high force density and relatively simple structure over other types of actuator. In this paper it has been the endeavor to present the design and manufacturing of a soft robotic gripper based on asymmetric flexible pneumatic/hydraulic actuator. The present work leads to very interesting application in the other areas as well.

4. Conclusion

Multifunctional grippers was designed to hold number of cylindrical objects at a time but which improved speed of assembly. However, compound gripper would also save time in interchanging gripper and also save expenses on two grippers.

Research Work has been carried on optimum design of Mechanical Gripper which was mainly for external object gripping. Grasping index, the new term derived should be taken into considered for flexibility and proper handling of objects.

Not much has been said about internal gripping and restricted to self-expanding rubber and vacuum so, the improvement can be made in existing gripper using the principle of concentric grippers. This can be made possible if we use compound two finger gripper instead of single .

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