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DEVICE FOR USE IN MANUFACTURING EQUIPMENT

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Abstract: The authors focus on modifying parts of the Rotational Universal Module joint system. The main task of the joint system is to create a solid bond between two adjacent modules. This is called the rotary coupling, because two adjacent modules rotate to each other. The main objective was to achieve improved locking system in comparison with the initial design. Also facilitate the assembly operation during the construction of kinematic structures. A detailed description of the adjustments made, see the following chapters.
Keywords: rotation universal module, rotary unit, locking pin, large flange of bearing

INTRODUCTION

Nowadays is possible to find in global markets tremendous number of robotic handling equipments that provide manipulations in space. It is recommended to use handling equipments which reach at least five degrees of movement freedom. This condition ensures successful manipulation in space.

Rotation Universal Module offers possibility of kinematic chains creation with such numbers of freedom degrees which are needed to fulfill the task [1]. The number of freedom degrees depends on number of modules that are connected to each other in the kinematic chain [2]. The first prototypes of Rotation Universal modules have been tested to detect inequalities, subsequently they were carefully analyzed and solved. Individual deficiencies and approaches how to remove them are described below.

ROTATION UNIVERSAL MODULE

Rotation Universal Module (URL) is a rotary module with an unlimited degree of rotational movement. URL is suitable for engines and equipment that need unlimited rotational movement freedom [3]. Rotation Universal Module is designed on modular principle that allows using one type of module to compile various combinations of engines.

If given solution is not suitable or is necessary to establish different kind of machine, it is possible thanks to modularity rebuild initial solution [4]. Other useless modules can be used in other applications. Proposed machines and equipment can achieve a huge variety of movement options and freedom degrees using the infinite rotation of adjoining modules that are joined together by motion joints.

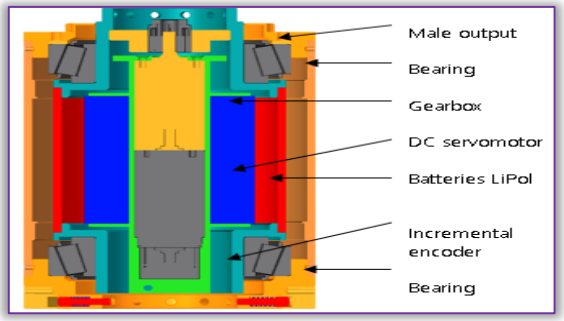

Figure 1. Cut the Rotation Universal Module flesh

Rotation Universal Module is designed to secure the unlimited rotation. That is reason why all components are placed in the body of the module (Figure 1). This makes the components protected against external influences. Each module is equipped with DC servo motor Faulhaber 3863 012C (204W, 12V, 85% efficiency) which is located in the middle of the module. The engine is equipped with an incremental encoder Faulhaber IE2-512 which can scan 102 400 positions per revolution. In the output of the engine is mounted reducer Faulhaber (38A, 200: 1, 20 Nm) with electro brake (6W, 12V 80Nm) which is located behind reducer. Module is equipped with leveling LiPo batteries 4in1 (14.8V) to secure permanent run also after power failure. [Skylight 2010b] The module is managed by PID

control servomotor. Output nominal speed of Rotation Universal Module is 30 revolutions / minute.

Final solution is a modular system which allows us to assemble modular robots that can be composed of identical type or typically identical Rotation Universal Module with limitless possibility of movement rotation. Engines and equipments that are built by these modules should ensure the best operating range and also the best achievement of desired location in the workspace [5].

THE MAIN COMPONENTS OF THE LOCKING SYSTEM

Primary part of the Rotation Universal Module locking system consists from twelve locking pins that are stored in milled grooves which are located around the perimeter of the large flanges of bearings. Rotary unit ensures the movement of the locking pin. Movement is secured by grooves that are milled inside of the rotary part. In order to ensure a smooth return movement of the locking pin, each locking pin have inside of housing stored spring. Restraint and tension adjustment of the rotary component is secured by four pins with spring-loaded ball. The pins are located on the outer periphery of the rotary part.

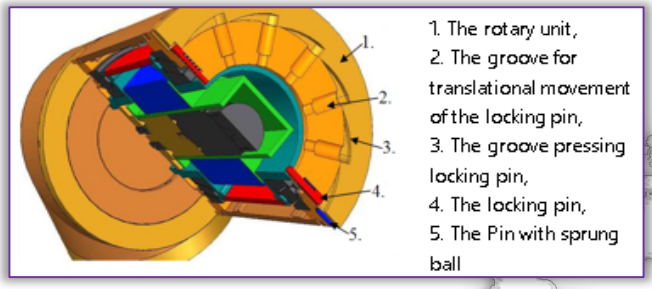

Figure 2. Components of the locking system

IDENTIFIED DEFICIENCIES OF THE LOCKING SYSTEM

Production of first three Rotation Universal Module prototypes enabled to perform a series of tests to identify deficiencies. These deficiencies in the design phase did not reveal to be critical, but during handling with Rotation Universal Module was clear that they need to be solved [6].

At the very act of locking the two adjacent modules, in which is needed to turned rotary unit clockwise. Twisting deteriorated into modules and thus undermines the achievement of the final position. In the final position, there is a protrusion of the locking pin and engagement with the aperture in the opposite parts. Finally it makes firm connection of two adjacent modules. The act of locking makes difficult also weight of one module that achieves 5 kg. To achieve the correct functionality of the device and facilitate locking action was needed to solve this problem. Acceded to the locking system modifies components namely large flange of bearings and a male output. Individual interventions are described below.

COMPONENTS MODIFICATION OF THE LOCKING SYSTEM

The entire locking system of Rotation Universal Module has been designed in a cylindrical shape (Figure 3). This shape makes it difficult to lock two adjacent parts, especially in cases where it is necessary to assemble complex devices. Given problem is also complicated because of weight of one module. The main problem occurs when is necessary to reach a final position in which the rotatable part is turned, and subsequently locking pins are inserted into the holes which are located in opposite parts. Result of this mechanism is really important - locking of two adjacent parts together. During rotation of rotary part there is an undesirable movement of connection module and this disrupts resultant position properly connection of two modules. This action is for an individual worker very difficult.

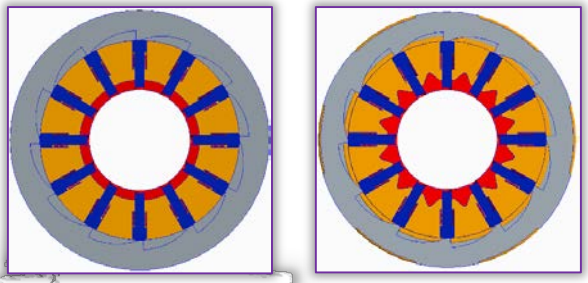

Figure 3. Cut the lock system before and after treatment

In order to resolve this issue we acceded to the adjustment of some parts of the Rotation Universal Module locking system - a large flange of bearings and a male output. As it is showed in Figure 4 both parts have had cylindrical shape in connection place. This causes slip recollection of modules and withdrawals to reach final position in the act of locking two modules together. It was necessary to propose a modification of given position that should be attained in each from twelve positions.

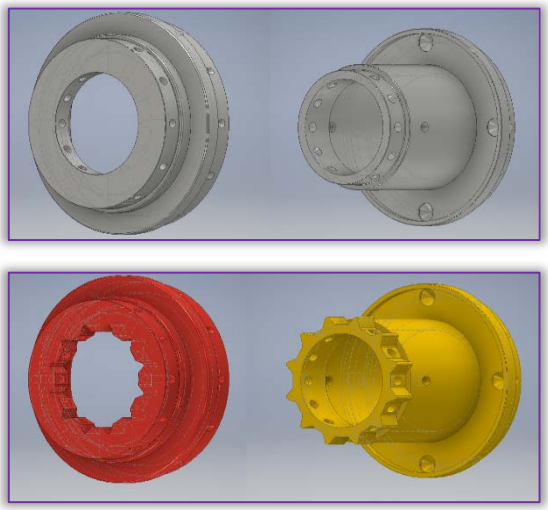

Figure 4. Large flange of bearing male and output before and after treatment

To meet this certain requirement we modified the shape of the parts of the original cylindrical shape to star-shape. Although this change is also problematic in manufacturing but in terms of installation and handling of the modules will bring great facilitate. As we can see from (Figure 4) into the large flange of bearings was needed to mill open triangular shape to achieve gear shape. Same approach has been designed also in males output. In this adjustment it was necessary to adjust one more component which has to achieve the same star-shape as in the previous two episodes. The change was necessary in order to fully prepare the module during its assembly. This procedure has no mechanical nature, but without it would be impossible to complete a module.

Thanks units adaption we have achieved the desired changes. Reassembly of engines and equipment with star-shaped Rotation Universal Module locking system (Figure 5) finally causes suitable grip during act of locking modules. The achievement of the final position is possible in all (twelve) positions.

CONCLUSIONS

Rotation Universal Module is a rotary module with unlimited rotation. Its main use is in construction of modular robotic devices with different movement freedom degrees. Thanks to testing and debugging of the prototype, deficiencies have been revealed. These have been adjusted according to the desired requirements. With a proactive approach and implementation of tests series in the future, we are able to remove all potential Rotation Universal Module shortcomings [7]. Finally the module will be tuned into the desired outcome with adjustments and debugging to get a satisfactory construction result.

Acknowledgments

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