Juraj Smrček, Radovan Neupauer, Peter Knut
Department of Industrial Robotics
Technical University of Košice
Štúrova 31, 08001 Prešov
Slovakia

Biomechanical gripper identification and testing its properties and parameters

Abstract – The intelligent robotic systems constructed according to the recent development trends include progressive IR, progressive G/IR and sensoric equipment. The specific group of G/IR are biomechanic grippers BG/IR, these constructions are arranged into the categorz of „intelligent grippers" recentlz. On the base of the knowledge from the mechanic and functional sets accuracz theorz, an approach for defining the characteristics and parameters G/IR set was formulated. The above mentioned approach to identification of BG/IR characteristics can be presented through experimental measuring held on BG/IR developed at the working place of the paper authors.

1. INTRODUCTION

Recent trends of the development of productive and manipulation processes automation lead to the new generations of automation szstems conceptually and principally based on BMS (Bionic Manufacturing Systems) or IMS (Intelligent Manufacturing Systems) models. Both models use specific technical devices set to complete logistic systems, so to secure the ability to recognize and analyze working and technology scene and to react correctly to unplanned situation for increasing the level of technical intelligence and development of informational level. The intelligent robotic systems constructed according to the recent development trends include progressive IR, progresssive G/IR, sensoric equipment and communication interface that would secure the adaptation activity and backward control of the functions of the whole robotic system in the given application environment.[3]

2. INDUSTRIAL ROBOT – ROBOTIC SYSTÉM

The industrial robot [IR] is automatically directed, reprogrammable multi-purpose manipulator machine used for automation of and manipulation operations.

The active mechanism [subsystem] of IR is finished by final effector [working tool - working organ] which relates to IR application. It can be said that the final effector [G/IR] is a special single-purpose device constructed for concrete conditions of IR usage [1].
G/IR represent working organs of robotical and manipulation devices. Regarding an intermediate interaction between the gripper and both manipulated objects and systém environment of the robot, the grippers are the most variable element of the robot consrtucton and are in common individually solved for single applications [7].

Construction of G/IR in robotic devices designed for an atypical environment (dangerous, health detrimental, underwater, cosmic space, domestic, etc) is more and more influenced by an effort to stimulate the abilities of human hand. But comparing it, G/IR are less perfect substitutions. Highly movable multi-fingered biomechanic G/IR are also an inseparable co-part of each biorobot/BMS [4], [5].

The paper deals with the problem of intelligent G/IR constructed on the base of biomechanisms. [BG/IR] developed at the working place of the paper authors.

3. BG/IR CHARACTERISTICS AND PARAMETERS

The notion of BG/IR relates to G/IR also, which shape and construction are analogical to the biological model (human hand), i.e. they are biomechanic model. These construcions are arranged into the category of "intelligent grippers" recently, the first constructions date back to the 80s of this century [3], [4], [5].

BG/IR technically copies kinematic of the biological model with the aim to approach the features and characteristics of gripping with fingers, thumb and palm (gripping by clamping, holding, squeezing) as much as possible. The analysis of gripping the objects by BG/IR and consequently seting of the model of identification of related characteristics and parameters are possible to base on the principle shown in the Fig.1.

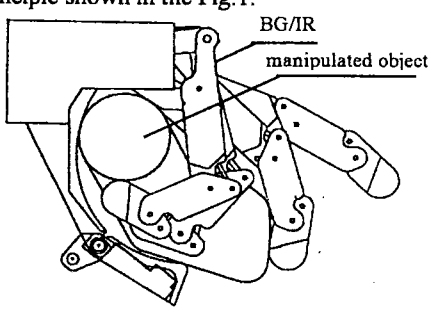


Fig. 1. Principle of biomechanic robot gripper.

Technical practice so far did not create the standard set of characteristics and parameters for

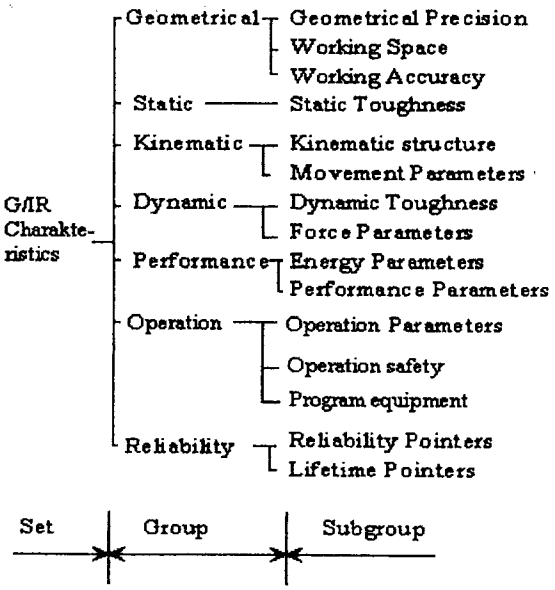


Fig. 2. G/IR characteristics and performance parameters.

complete evaluation of G/IR features. On the base of knowledge from mechanic and functional sets accuracy theory, an approach for defining of characteristics and parameters G/IR set was formulated. The set is structured to a system approach of functional relations to quantitative and qualitative consideration of G/IR features Fig. 2, [8], [9].
Each group is filled with concrete parameters (parameters of relevant standards/ISO standards are taken into consideration, too), generally valid for G/IR type of machines [2], [6], [8], [9]. The set is constructed as an open systém that can be completed on the base of new information and demands.

4. EXPERIMENTAL VERIFICATION OF BG/IR PARAMETERS AND THEIR INTERPRETATION

The mentioned approach to identificaton of BG/IR characteristics can be presented through experimental measuring held on BG/IR developed at the working place of the authors named „Prešov Biomechanical Robot Gripper", Fig. 3.

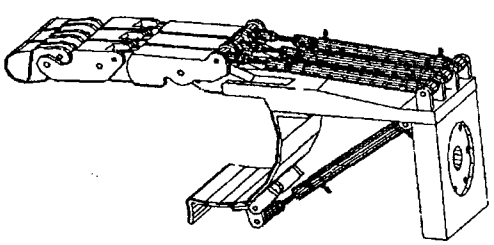
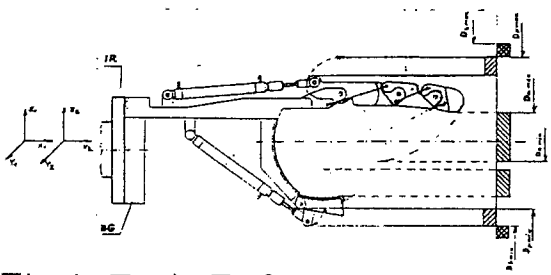


Fig. 3. Line dawing of the Presov Biomechanical Robot Gripper

A choice of typical "mechanic" parameters, especially important for evaluation of this category of G/IR is given here.



inactive, active, safeness
Dpmax - outline of maximum motional area, Dpmax/Dpmin - definition dangerous area

Fig. 4. BG/IR Characteristics and parameters of working space

1. Working space – the space value of the space given by BG/IR construction that is necessary for BG/IR functions (passive space) and that is created for gripping of manipulated object (active space), Fig. 4. Working accuracy given fig. 5.

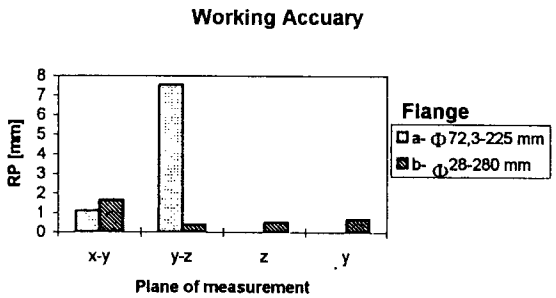
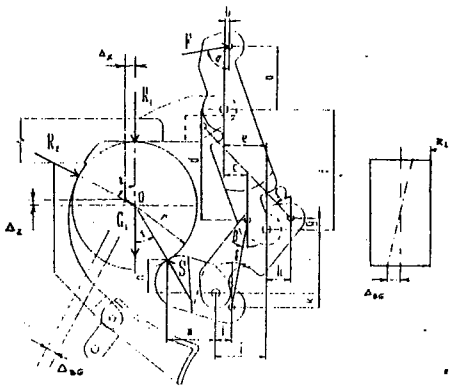


Fig. 5 BG/IR characteristics and parrameters of working accuracy

2. Undirectional pose/orientation accuracy and reliability - gripping-accuracy of manipulated objectgripped during a repeated expansion and contraction of active parts (articles) of BG/IR, Fig. 6. The parameters are dependent on the accuracy and repeatability of making the way and position of BG/IR parts during gripping of the object.

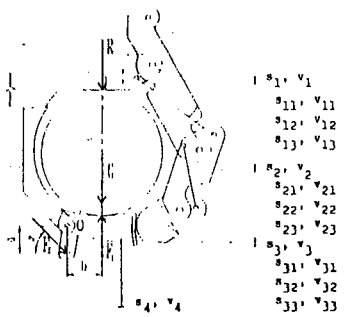
3. The parameters of movement - express the level of identification among the real routes and their speeds that are made by the different parts of BG/IR during n-repetitions of programmed movement "open-close" realizations. The level of identification is connected with the registered deviations in the course of the real values from related values (the first realization), Fig. 7. Stability (balancing) of these parameters could be a part of evaluation, too.



$\Delta_{BG} = f/\Delta_{xBG}, \Delta_{yBG}, \Delta_{zBG}/$

Fig. 6. BG/IR characteristics and parameters of gripping accuracy

4. Power relations – express the power parts and relevant forces from the speed components of IR movement in the relation to the security of manipulated object gripping during whole time of IR manipulation with the given object. The basic relations are given by Fig. 1, Fig. 7, the decisive "critical" influences on given parameters are balancing of energy feeding values, the position of the object from the point of view of a gravity and orientation of BG/IR components during its fripping, speed parameters of IR movement. Maximum load at grip with is thumb m=1,878 kg and with fingers m=1,712kg.



i - number of phalanges
j - number of fingers

Fig. 7. BG/IR characteristics and parameters of movement.

5. Safety level – expresses essential and necessary BG/IR features from the point of view of safe IR using or BG/IR. There are mainly features and functions of emergency stop (BG/IR must have a "close" stop), safe space control in the relation to application, resistance to energetic (short-time) breaks, blocking system control.

5. CONCLUSION

Introduced model of G/IR characteristics and parameters identification was tested on BG/IR and also on "classical" G/IR. The results affirmed suitability of the model conception as well as practical usability of identified parameters during G/IR construction or their setting into concrete applications [5], [8], [9].
It is possible to secure reliable and safe clamping of manipulated objects in the period of G/IR design, in the period of G/IR setting to secure diagnostics of the influence of clamping inaccuracy and by this secure "stability" of this process and consequently influence the quality of whole automation process in which IR is set, this all through using of the possibilities of shown approach and its algoritms.

6. ACKNOWLEDGEMENTS

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