Work. Serv. Robot. 2018. Pp. 47–58. [M. A. ... & Leonardi and Aquino P. Junior, "Robotic Manipulators ..." in ... pp. 47–58, 2018.]

11. ... | Redefining Robotics and Manufacturing | Rethink ... [Online]. Available: ...w.rethinkrobotics.com/products/baxter (accessed: ...). [Baxter | Redefining Robotics and Manufacturing | Rethink Robotics ... . [Online]. Available:https://web.archive.org/... http://www.rethinkrobotics.com/products/baxter .]

12. ... Anytime Motion Planning for Prehensile Manipulation ... / A. ... // IEEE-RAS International ... Vol. 2018. Pp. 874-880. ... [A. ..., "Anytime Motion Planning for ... Manipulation ...", ... vol. 2018, pp. 874-880, ...]

13. Object Placement Planning and optimization for Robot Manipulators / J. A. ... // IEEE International ... Pp. 7417-7424. DOI: ... [J. A. ..., "Object Placement Planning and optimization for Robot Manipulators", in ... pp. 7417-7424, ... DOI: ...]

14. Manipulation planning with directed reachable volumes. ... // International ... Intelligent Robots and Systems. 2017. Vol. 1. Pp. 4026–... DOI: ... [... "Manipulation planning with directed reachable volumes", in ... vol. 1, pp. 4026–..., 2017. DOI: ...]

15. Analysis of the effectiveness path planning methods and algorithm for the anthropomorphic robot manipulator / V. Petrenko et al. // ... Proceedings. ... DOI: ... [V. Petrenko, et al., "Analysis of the effectiveness path planning methods and algorithm for the anthropomorphic robot manipulator", in ... DOI: ...]

16. The method of the kinematic structure reconfiguration of a multifunctional modular robot based on the greedy algorithm / V. ... // Proceedings - International ... vol. 2020. Pp. 42-47. DOI: ... [V. ..., "The method of the kinematic structure reconfiguration of a multifunctional modular robot based on the greedy algorithm", in ... vol. ..., pp. 42-47, ... DOI: ...]

17. Kinematic analysis anthropomorphic gripper with group drive / V. ... // IOP Conference Series: Materials Science and Engineering. ... DOI: ... [V. ... et al., "Kinematic analysis anthropomorphic gripper with group drive", in IOP Conference Series: Materials Science and Engineering, ... DOI: ...]

18. The method of forming a geometric solution of the inverse kinematics problem for chains with kinematic pairs of rotational type only / V. ... // IOP ... Multidisciplinary ... Modern Issues in Science and Technology/Workshop Advanced Technologies in Aerospace, Mechanical and Automation Engineering 2018. DOI: ... 4/042016 [V. ..., "The method of forming a geometric solution of the inverse kinematics problem for chains with kinematic pairs of rotational type only", in ... Multidisciplinary ... Modern Issues in Science and Technology/Workshop Advanced Technologies in Aerospace, Mechanical and Automation Engineering, ... DOI: ... 042016.]

19. Cooperative Motion Planning Method for Two Anthropomorphic Manipulators / V. ... // ... Inf. Technol. Intell. Decis. Mak. Support ... Vol. 1. Pp. 146-... [V. ..., "Cooperative Motion Planning Method for Two Anthropomorphic Manipulators", in ... vol. 1, pp. 146-...]

20. The method of the quasioptimal per energy efficiency design of the motion path for the anthropomorphic manipulator in a real time operation mode / V. ... et al. // ... 2018. Vol. 2. Pp. ... [V. ..., "The method of the quasioptimal per energy efficiency design of the motion path for the anthropomorphic manipulator in a real time operation mode", in ... vol. 2, pp. ... 2018.]

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METADATA

Title: Algorithm of machine learning for the control system of anthropomorphic manipulators.

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Abstract: The article proposes an algorithm for training a control system for two anthropomorphic manipulators with 7 degrees of mobility, which have intersecting working areas. The algorithm is based on deep learning technology with reinforcement of an artificial neural network (ANN). The paper also describes the practical implementation of a manipulator control system based on ANN, which allows to avoid collisions and achieves an average accuracy of reproducing the target positions of the manipulator grips of 98.3%. The results obtained indicate that the proposed method is promising for the development of control systems for anthropomorphic machine learning. manipulators based on deep reinforcement

Key words: anthropomorphic manipulator; kinematics; artificial neural network; machine learning.

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