ABSTRACT
of thesis
"Research of the RoboMech class parallel manipulators"
submitted in candidacy for the PhD degree
in 6D071200 – "Mechanical Engineering"
by
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Assessment of the current state of the scientific and technological problem (task) being solved:

The increase in the reliability and longevity of machines is usually associated with the transition to new high-quality materials, the improvement of processing technology of details, the use of different means. However, the basic qualities of the new machine and the manipulative device are laid in them at the first stage of design, when only the structural scheme and geometric parameters of the components of the executive mechanism are selected. Therefore, it is more purposeful to fight with the root causes of harmful phenomena than with their consequences. It is better to eliminate large overloads by rational choice of structures and geometric parameters of the links of the executive mechanism, than to choose particularly strong materials, capable of withstanding these overloads.

Basic processing of data topics. According to this assignment, a parallel manipulator is being designed at the ALATAU "DOC Co. Ltd." plant, which is engaged in the production of molds, for feeding and removing a workpiece weighing 50-100 kg into the working area of the CNC vertical machining center HAAS VM-3 according to the cylindrical coordinate system.

Manipulators are divided into two main groups: serial manipulators and parallel manipulators (PM). On the basis of the literature review carried out, we have chosen the PM. Serial manipulators consist of an open kinematic chain connecting a fixed base and an end-effector (output point). Due to the serial connection of their links, many disadvantages appear. First, an open kinematic chain cannot provide high accuracy due to the accumulation of errors in individual components in the composition. Secondly, due to the gravity of the engine balance in active kinematic pairs, the movement becomes unstable and cannot work at high speeds due to the non-rigid structure. Accordingly, an open kinematic chain reduces the speed of the manipulator, reduces its dynamic characteristics and has a lower positioning accuracy and load capacity.

The PM consists of at least two kinematic chains or legs connecting fixed and output links. The disadvantages of serial manipulators can be eliminated by using PM. First, their accuracy will be higher, since their moving components will be closely related to each other, and link errors will not accumulate. In this case, PM have a more rigid design than sequential ones, since the corresponding weight affects at least two kinematic chains. The units moving on the parallel robots will be lighter in weight, since all the motors will be located on a fixed platform, therefore, the

parallel robots can work at high speeds, with high accuracy, and the lifting capacity is higher.

Reliability of work was found a structural diagram and optimal geometric parameters of PM, PM with three degrees of freedom was calculated for strength in the SolidWorks software system using a force of 1000N at the output point P and proved the suitability of the proposed design. The reliability of the work is also confirmed by articles and two patents published in the indexed journals MDPI Robotics, MDPI Applied Sciences and Eastern-European Journal of Enterprise Technologies in the Web of Science and Scopus databases.

Relevance of the research topic:

The optimal structural schemes and geometric parameters of the links of two PM were determined: PM with three degree of freedom and PM with two sliders, PM with three degree of freedom was designed for strength in the SolidWorks software environment and with an applied force of 1000N at the output point P and the suitability of the proposed design was proved. The reliability of the work is also confirmed by articles published in the indexed journals, MDPI Robotics, MDPI Applied Sciences and the Eastern European Journal of Advanced Technologies in the web databases of Science and Scopus, and with two patents of the Republic of Kazakhstan.

According to the instructions of the ALATAU "DOC Co. LTD" plant, engaged in the production of molds, a RoboMech class PM is being designed for feeding and removing a workpiece weighing 50-100 kg into the working area of the the CNC vertical machining center HAAS VM-3.

Purpose of work:

development of two PMs of the RoboMech class: a PMs with three degrees of freedom, operating in a cylindrical coordinate system, and PM with two-sliders, as well as the use of a PM with three degrees of freedom at the ALATAU "DOC Co. LTD", engaged in the production of molds.

Object of research are the RoboMech class PMs with three degree of freedom operating in a cylindrical coordinate system and PM with two-sliders.

Subject of research are structural-parametric synthesis, forward and inverse kinematics, strength analysis of PM with three degrees of freedom and PM with two sliders.

The main objectives of the thesis:

1) A literature review and justification of the relevance of the study;

2) Structural-parametric synthesis of two RoboMech class PMs: PM with three degree of freedom and PM with two sliders.

3) Direct and inverse kinematics of the PM with three degree of freedom and PM with two sliders.

4) 3D modeling of parallel manipulators of a RoboMech class;

5) Development of new patentable parallel manipulators of a RoboMech class;

6) Strength analysis of PM with three degree of freedom.

Scientific novelty:

- the methods of structural-parametric synthesis of two RoboMech class PMs have been developed: PM with three degree of freedom and PM with two sliders;

- the direct and inverse problems of the kinematics of these two RoboMech class PMs have been solved;

- the strength analysis of the PM with three degree of freedom, operating in a cylindrical coordinate system, was carried out;

- received two patents for the PMs with three degree of freedom and PM with two sliders.

Provisions to be defended: The main result submitted for defense is the determination of the optimal structural schemes, geometric parameters of links, kinematic and strength parameters of two RoboMech class PMs: PM with three degrees of freedom and PM with two sliders.

The practical value of the thesis. The developed two RoboMech class PMs, in comparison with serial and other PMs, have a large carrying capacity, high positioning accuracy and a simple control system.

PM with three degree of freedom, working in a cylindrical coordinate system, can be used to feed and remove a workpiece weighing 50-100 kg into the working area of the CNC vertical machining center HAAS VM-3 for the ALATAU "DOC Co." LLP plant. LTD ", which is engaged in the production of molds. The PM with two slides can be used to automate stamping operations in small machine-building enterprises.

Publications:

1. Baigunchekov Z., Mustafa A., Sobh T., Patel S., Utenov M. A robomech class parallel manipulator with three degrees of freedom. Eastern-European Journal of Enterprise Technologies 3(1-105), (2020), pp.44-56, (Scopus: Percentile 55).

2. Zhumadil Baigunchekov, Med Amine Laribi, Azamat Mustafa. Kinematic Synthesis and Analysis of the RoboMech Class Parallel Manipulator with Two Grippers. Robotics, 2021, 10(3), 99, 16p (Q 2, Percentile 67, Cite score 3,5).

3. Zhumadil Baigunchekov, Med Amine Laribi , Giuseppe Carbone, Azamat Mustafa , Bekzat Amanov, Yernar Zholdassov. Structural-Parametric Synthesis of the RoboMech Class Parallel Mechanism with Two Sliders. Applied Sciences, 2021, *11*(21), 9831; 18 p. (Q 2, Percentile 71, Cite score 3.0, WoS IF 2.679).

4. Baigunchekov, Z., Tarek, S., Patel, S., Mustafa, A. Structurally Parametric Synthesis of a RoboMech Class Parallel Manipulator with Three DOF. Mechanisms and Machine Science, 84, (2020), pp. 371-379, (Scopus: Percentile 23).

5. Байгунчеков Ж.Ж., Мустафа А.К., Кадыров Ж.Н., Параллельный манипулятор класса РобоМех с тремя степенями свободы. Патент № 34390 на изобретение.

6. Байгунчеков Ж.Ж., Мустафа А.К., Кадыров Ж.Н., Кривошипно-двухползуный механизм. Патент № 34380 на изобретение.

The structure and volume of the thesis.

The dissertation work consists of an introduction, three chapters, a conclusion, a bibliography and appendix. The total volume of work is 109 pages, 32 figures and 8 tables, 90 used sources.