Intent Research Scientific Journal-(IRSJ)
ISSN (E): 2980-4612
Volume 4, Issue 3, March - 2025
Website: intentresearch.org/index.php/irsj/index

CONSTRUCTION OF STRUCTURAL AND KINEMATIC SYSTEM OF MANIPULATORS

L.F.F. Sharipov Shukhrat Pulatovich
Workplace: Karshi State Technical University
Position: Associate Professor (PhD)
Address: Kashkadarya Region, Kasbi District, Akqamish Rural Municipality, Navbahor Neighborhood, Babur Street, House 4
Email: shuhrat.sh2811@gmail.com

Abstract
This article examines the construction of structural and kinematic schemes of manipulators. The application of manipulators in industry, medicine, aviation, the military sector, and scientific research is analyzed. The main structural components of manipulators, degrees of freedom, and types of kinematic chains are discussed. Structural schemes describe the mechanical design of manipulators, while kinematic schemes help to understand their movement principles and optimize their performance.

Keywords. Manipulator, structural scheme, kinematic scheme, degrees of freedom, industrial robots, mechanical systems, automation, robotics.

Introduction
Manipulators are mechanical systems designed to perform the functions of a human hand. They consist of movable joints to perform various tasks and are widely used in industry, medicine, aviation, astronautics and many other fields. The following main aspects determine the importance of manipulators:

- **Increase productivity** – Manipulators increase production efficiency by performing high speed and precise movements.

- **Accuracy and repeatability** – Modern manipulators can perform complex operations with very small errors.

- **Working in difficult and dangerous conditions** – Manipulators can operate in environments that are dangerous to humans, such as radiation, high temperatures, or low-pressure environments.

Intent Research Scientific Journal-(IRSJ)
ISSN (E): 2980-4612
Volume 4, Issue 3, March - 2025
Website: intentresearch.org/index.php/irsj/index

Flexibility – They can be configured to perform a variety of actions through software control.Manipulyatorlarning qo‘llanilish sohalari.

- **1. Industrial robotics**
- Used in production lines in processes such as assembly, welding, painting, and transportation of parts.
- Widely used in industries such as automotive, electronics, and metalworking.

2. **Medicine**

- In minimally invasive surgical operations (e.g., the Da Vinci surgical robot).
- Manipulators that replicate human movements are used in prosthetics and rehabilitation processes.

3. **Space exploration and aviation**

- Used by **NASA** and other space agencies in the repair and assembly of satellites, spacecraft, and the International Space Station**.**
- Remotely controlled manipulators are used to explore planets like Mars.

4. **Military sector**

- Robot manipulators are used to neutralize explosives.
- Used as part of drones and other mobile platforms in reconnaissance and security operations.

5. **Agriculture and food industry**

- Used in fruit picking, food packaging, and other processes.
- Manipulators integrated with artificial intelligence help automate agricultural work.

6. **Scientific research and education**

- Manipulators are used for scientific research and experiments in robotics and mechatronics.
- It is used in universities and research centers to study various modeling and automation processes.

A structural diagram of a manipulator is a graphical model that represents its main components and their relationships. Structural diagrams are used to understand the mechanical structure of manipulators and to design them.

Intent Research Scientific Journal-(IRSJ)
ISSN (E): 2980-4612
Volume 4, Issue 3, March - 2025
Website: intentresearch.org/index.php/irsj/index

The structural diagram of the manipulator reflects the following main elements:

- **Basis** – A support used to secure the manipulator.
- **Joints (link)** – The moving parts of the manipulator determine the type of movement.
- **Kinematic pairs** – Mechanical connections between joints to transmit motion.
- **Working organ (effector)** – The final element of a manipulator that directly interacts with objects (for example, a robotic arm or a ruler).

- **Types of structural diagrams:**

1. **Serial manipulators** – The links are arranged in a row, each connected to the previous one (for example, industrial robots).
2. **Parallel manipulators** – Multiple links are connected in parallel, providing high accuracy and stability (e.g., Stewart platform).
3. **Hybrid manipulators** – Combination of series and parallel structures.

Kinematic diagram of manipulators – This is a model that describes the principles of their movement and the interconnection of mechanical movements. Kinematic diagrams play an important role in determining the geometry and degrees of freedom of movement of manipulators.

- **The main elements of the kinematic scheme:**
- **Degree of freedom of movement (DOF - Degree of Freedom)** – The number of independent directions of motion of the manipulator. For example, the human hand has 7 degrees of freedom of motion.
- **Kinematic pairs** – Types of mechanical connections connecting the manipulator joints.

Reinforced pairs (revolutionary connections) – Provides rotational movement.

- **Prismatic pairs** – Provides linear motion.

Types of kinematic schemes:

1. **Open kinematic chains** – Each link is connected to only one previous and next link (e.g., a typical robot manipulator).
2. **Closed kinematic chains** – The directions of movement form a closed loop, which increases accuracy and stability (e.g., parallel manipulators).

Intent Research Scientific Journal-(IRSJ)
ISSN (E): 2980-4612
Volume 4, Issue 3, March - 2025
Website: intentresearch.org/index.php/irsj/index

How to draw a kinematic diagram?

1. Determine the geometry of the manipulator
2. Calculate the degrees of freedom of movement
3. Establish the relationship between kinematic pairs and joints
4. Mathematical analysis of the model (D-H parameters, equations of motion, inverse kinematics)

Conclusion

Manipulators are an integral part of modern technologies, and the correct design of their structural and kinematic schemes is of great importance. Manipulators are widely used in industry, medicine, the military, aviation and other fields. While structural schemes describe the general structure of manipulators, kinematic schemes help to understand the principles of their movement.

References

1. Craig, J. J. Introduction to Robotics: Mechanics and Control. – Pearson, 2017. (The main source on the mechanics and control of manipulators.)
2. Spong, M. W., Hutchinson, S., Vidyasagar, M. Robot Modeling and Control. – John Wiley & Sons, 2006.(A fundamental work on the kinematics and dynamics of robotic manipulators.)
3. Tsai, L. W. Robot Analysis: The Mechanics of Serial and Parallel Manipulators. – Wiley, 1999.(A complete guide to the mechanics and structural diagrams of serial and parallel manipulators.)
4. Merlet, J. P. Parallel Robots. – Springer, 2006.(A book dedicated to parallel manipulators and their applications.)
5. Angeles, J. Fundamentals of Robotic Mechanical Systems: Theory, Methods, and Algorithms. – Springer, 2014.(A detailed resource on mathematical modeling of robotic mechanical systems.)
6. Khatib, O. (Ed.) Springer Handbook of Robotics. – Springer, 2016.(A guide to the latest research and technological approaches in robotics.)
7. Asada, H., Slotine, J. J. E. Robot Analysis and Control. – Wiley, 1986.(A work that describes methods for monitoring and controlling the movement of manipulators..)

ISSN (E): 2980-4612
Volume 4, Issue 3, March - 2025
Website: intentresearch.org/index.php/irsj/index

8. Федоров, М. П., Герасимов, Д. Н. Механика роботов и манипуляторов. – Москва: Изд-во Машиностроение, 2013.(Important Russian-language literature on the mechanics of robots and manipulators.)
9. Зуев, В. А. Кинематика и динамика манипуляционных роботов. – Санкт-Петербург: Политехника, 2018.(An authoritative Russian-language guide to kinematic and dynamic models of manipulators.)
10. ISO 9787:2013 Robotics — Manipulating industrial robots — Coordinate systems and motion nomenclatures. – International Organization for Standardization, 2013.(Sanoat robotlari va manipulyatorlarning koordinata tizimlari va harakat turlari bo‘yicha xalqaro standart.)
11. Sh. Sharipov, M. Ergashev. Improved leveler of a combined machine // AGRO ILM. – Tashkent, 2022. – No. 3. – P.83-84.
12. Pulatovich, Sharipov Shukhrat. “The influence of the opening angle of the soil pusher of a combined leveler on its performance.” European Journal of Artificial Intelligence and Digital Economy 1.2 (2024).
13. Pulatovich, Sharipov Shukhrat. “The influence of the opening angle of the soil pusher of a combined leveler on its performance.” International Journal of Recent Scientific Researcher's Theory 1.3 (2023): 149-152.
14. Sh. Sharipov, M. Ergashev. Improved leveler of a combined machine // AGRO ILM. - Tashkent, 2023. - No. 3. - P.60-62.
15. Pulatovich S. S. The influence of the opening angle of the soil pusher of a combined leveler on its performance // European Journal of Artificial Intelligence and Digital Economy. – 2024. – T. 1. – No. 2. – pp. 53-56.
16. Pulatovich S. S. Influence of the opening angle of the soil pusher of a combined leveler on its performance // International Journal of Recently Scientific Researcher's Theory. – 2023. – T. 1. – No. 3. – pp. 149-152.