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## DESIGN OF INDUSTRIAL ROBOT WITH INCREASED LOCOMOTION

**Urgency of the research.** *One of the top trends in the field of mechanical engineering is automation. An inherent part of automation in today's businesses is industrial robots of various categories. In today's industrial production, human and robot are usually separated from each other in order to avoid potential collisions. Continuous development and the growing trend of robotics, in order to increase competitiveness, abandons this individual and isolated robot deployment and prevents group-building of human-robot workplaces.*

**Target setting.** *The reason for designing industrial robots with capacity around 5-10kg according to human anatomy is that the transition from semi-automated production (operating lines controlled by operators) to fully automated production requires industrial robots that have dimensions similar to human anatomy.*

**Actual scientific researches and issues analysis.** *The current production of robot devices reaches a high technical level, which is further enhanced by the continued development of their subsystems, but also by the upgrading of functional principles and elements that are involved in the architecture and morphology of these devices.*

**The research objective.** *To what extent is it possible for the work process to be mechanized or automated depends also on the level of development of the used equipment. In today's development stage, design of automated device is also automated.*

**The statement of basic materials:** *From the point of view of approaching the design of robots systems means a common sign is a mechatronic approach. Robots technical devices are a typical product with all the features of mechatronics (linking knowledge of engineering, management methods and artificial intelligence). This becomes the starting point for the elaboration of the methods of designing robots at all.*

**Conclusions.** *This article focuses on the design of the robotics devices, whose main task is to perform the assembly. The future of deploying human-robot collaboration has enormous boundaries and many variables that still need to be addressed. It is important to remember that this technology is not about replacing people with robots. Rather, it is about using robust human features and robot strengths to achieve a new level of efficiency and productivity that could not be achieved by self-employment.*

**Keywords:** *industrial robot, assembly, robotics, production cell*

*Fig.: 6. References: 12.*

**Introduction.** One of the top trends in the field of mechanical engineering is automation. An inherent part of automation in today's businesses is industrial robots of various categories. Another very significant trend is the reduction of production costs, which forces engineers working in the field of development to continually work on new technology solutions that bring cost savings to the same productivity. In the case of this work, this is a design of an industrial robot applicable in the field of automotive production, hired when mounted in assembly lines. The aim was to design a device that is capable of replacing two industrial robots, a collaborative robot and a human worker [1; 3].

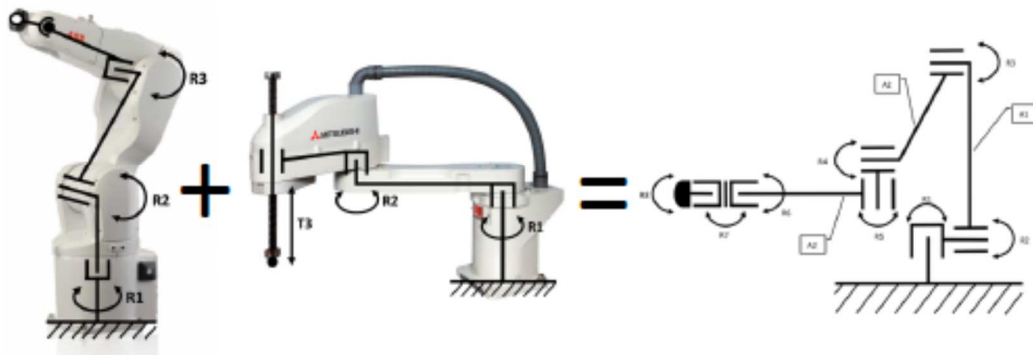
Robotic installations are currently fully-developed technical systems that are standardized into manufacturing systems in industries, expanding their use in non-productive and non-industrial sectors, and starting to move dynamically to service activities. The current production of robot devices reaches a high technical level, which is further enhanced by the continued development of their subsystems, but also by the upgrading of functional principles and elements that are involved in the architecture and morphology of these devices [4; 6; 8].

In current industrial production, man and robot are usually separated from each other to prevent possible collisions. Continuous development and growing robotic trend to increase competitiveness, abandoning this individual and isolated robot deployment, and preventing group robot building.

### Concept of kinematics

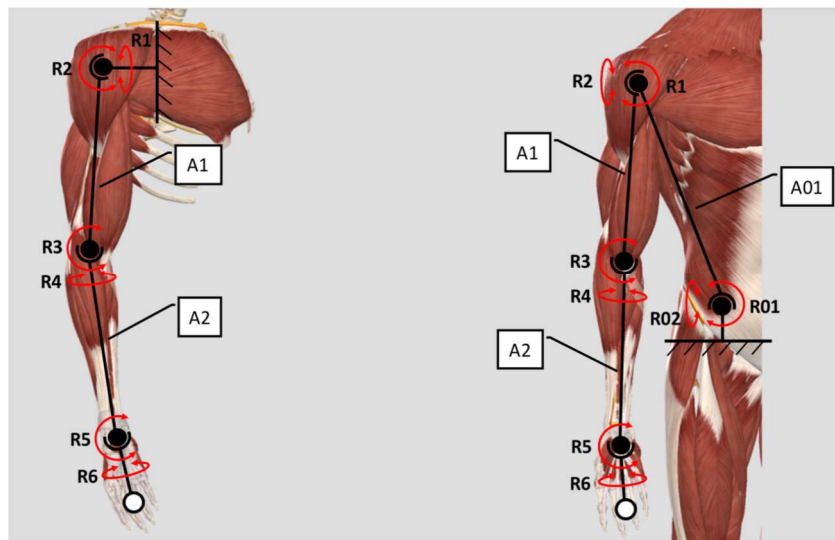
The main idea behind the task is to create a kinematic chain that consists of a kinematics of a SCARA industrial robot and 6 axis industrial robot with an angular workspace, fig. 1 [2; 7].

By combining these two kinematic chains, we get to a totally new kinematic chain and thus to a whole new category of industrial robots. Such a kinematic chain has a higher handling capability and a new "latching" function that is applicable to events when it is necessary to circumvent the obstacle from the side.



*Fig. 1. Proposal of the kinematic concept*

Currently, industrial robotics uses the concept of a shoulder, which is based on the comparison of the anatomical construction of the upper limb of a human being called "hand". The proposed kinematic chain concept is shifted to the concept of "hand and hull" when compared to human anatomy, fig. 2 [5; 9].



*Fig. 2. View kinematic on human anatomy*

The reason for designing industrial robots capacity around 5-10kg according to human anatomy is that the transition from semi-automated production (operator-operated workplaces) to fully automated production requires industrial robots that have dimensions similar to human anatomy. For companies, in the field of automotive, it is preferable to modify actual production or, projects by deploying industrial robots to build new fully automated production lines. These lines are ergonomically designed to provide operators with the most natural and health-conscious jobs in their jobs [10; 11].

From practice, we can determine that the width of jobs is about one meter. Therefore, it is necessary to consider this fact in the design of the industrial robot and to choose the shoulder size accordingly.

On the basis of the analysis carried out, a solution was proposed for the operation of the standard workplaces. The design includes three arms that increase the handling capacity of the industrial robot. The kinematic chain is inspired by the SCARA and angular industrial robot links, Fig. 3.

This solution, by adding another degree of freedom, becomes slightly more complex from a structural point of view. Also, by adding any additional degree of freedom, the task becomes more complex in terms of governance as well. Each arm layout is to a certain extent governed

by a spring as a spring, thus vibrations are generated, and the exact positioning of the end member is all the more complicated. For these reasons, it is necessary to choose components with sufficient stiffness and low will, which is more demanding and costly [11; 12].

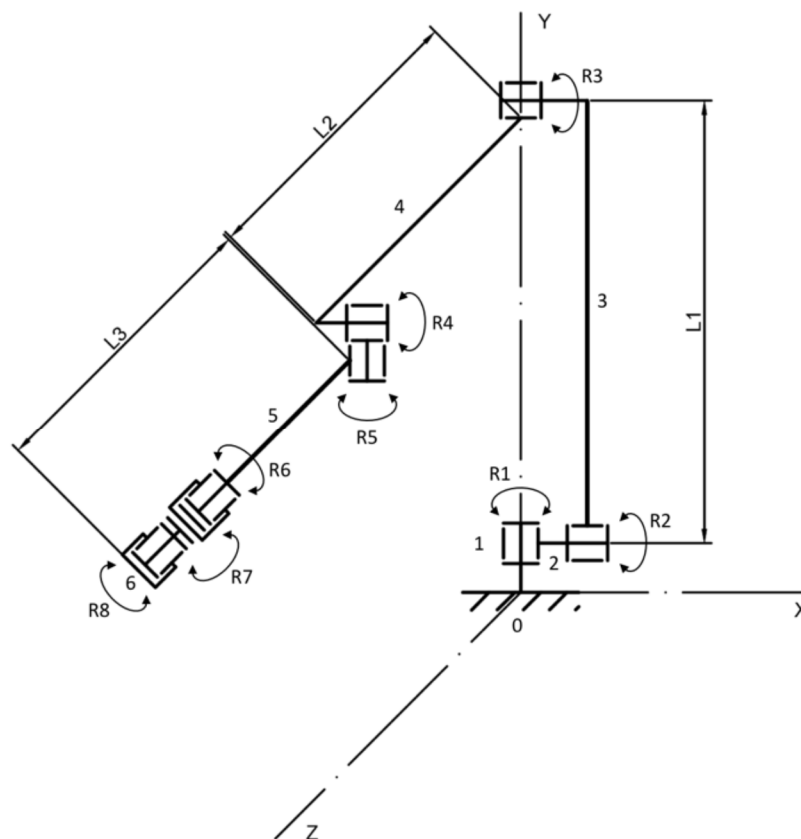


Fig. 3. Kinematics of robot

advantages:

1. Higher handling ability
2. Ability to bypass obstacles from the side
3. The ability to move in SCARA mode at any height
4. Control of axle distance when moving in SCARA mode

disadvantages:

1. Design requirements
2. Rigorous management
3. Higher costs

**Design of robot dimensions**

Based on the analysis of existing workplaces and on the basis of the requirements of businesses for a space for easy maneuvering activities (up to 10kg), I propose, based on the human anatomy model, the ratio of shoulder to arm 2 - 2: 3. Thus the suggested dimensions are as follows:

- L1 600 [mm]
- L2 400 [mm]
- L3 500 [mm]

Based on the robot kinematics I suggested the following workspace:

The anguloid workspace has the largest dimension of 1500mm, which is the range of the proposed industrial robot. Fig. 4 shows the robot kinematics in a stretched position (full line) and also in the SCARA mode (dashed line).

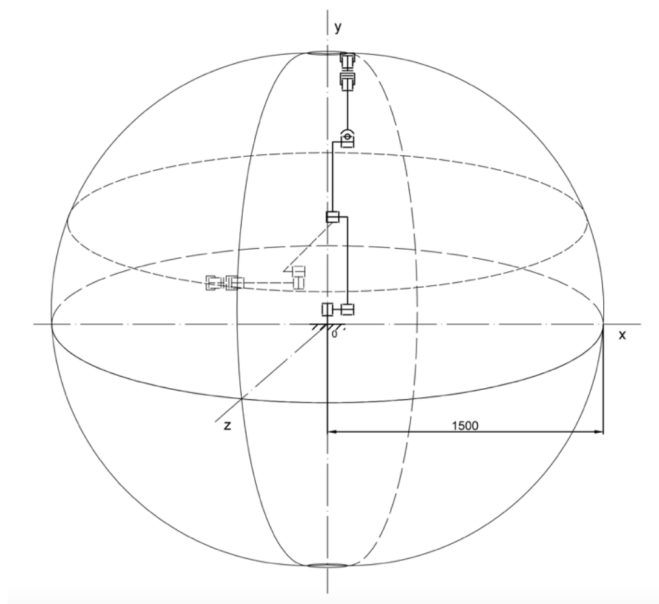


Fig. 4. Design of the robot workspace

#### Assembly of the proposed industrial robot

The methodology of the thesis is as follows:

- calculation and design of the propulsion system, simulation from the calculations is in fig. 5.

- modeling of parts and sub-assemblies from the robot end - the reason for this methodology is possible SolidWorks calculates moments of inertia of the parts of the robot and the team

then simple calculation and design of other drives from the effector to the carousel,

- creation of robot assembly fig. 6

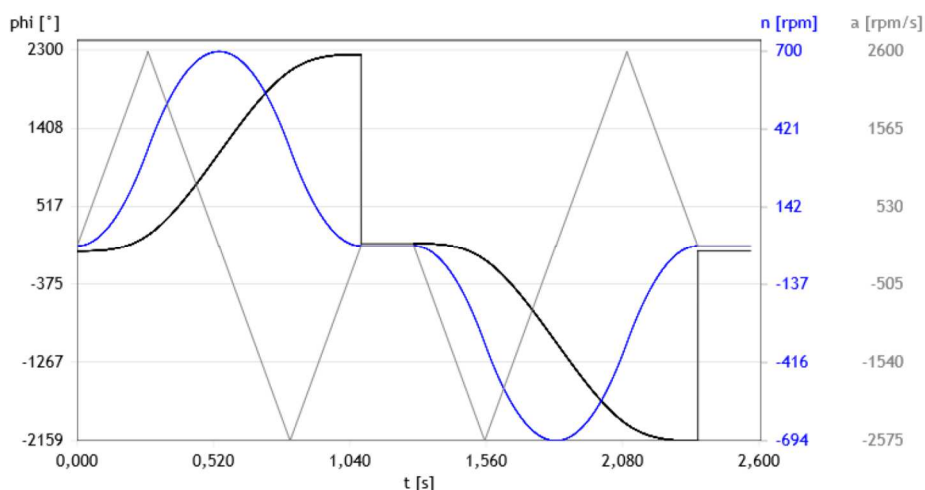


Fig. 5. Simulation from the CAE system



*Fig. 6. Design of robot*

**Conclusion.** At present, a large proportion of industrial activities are carried out using robots. Nevertheless, manpower is still done manually, where a human worker has added value for performing tasks that the robot can't (or very difficult) perform. That is why new opportunities are opened and thinking about the types of applications where it is possible to combine individual tasks of the robot and human work. This is accomplished by deploying cooperating robots to production lines and workplaces. The future of deploying human-robot collaboration has enormous boundaries and many variables that still need to be addressed. It is important to remember that this technology is not about replacing people with robots. Rather, it is about using robust human features and robot strengths to achieve a new level of efficiency and productivity that could not be achieved by self-employment.

#### **Acknowledgement**

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**КОНСТРУКЦІЯ ПРОМИСЛОВОГО РОБОТА З ПІДВИЩЕНОЮ ГНУЧКІСТЮ**

**Актуальність теми дослідження.** Одним з основних напрямків у галузі машинобудування є автоматизація. Невід'ємною частиною автоматизації сучасних підприємств є промислові роботи різних категорій. У сучасному промисловому виробництві людина й робот зазвичай відокремлені один від одного, з метою уникнення можливих протиріч. Безперервний розвиток робототехніки і зростаюча тенденція її конкурентоспроможності зумовлюють необхідність розташування цього робота окремо, ізольовано, що запобігає масовому створенню робочих місць людина – робот.

**Постановка проблеми.** Причиною проектування промислових роботів вантажопідйомністю близько 5-10 кг відповідно до анатомії людини є те, що для переходу від напівавтоматичного виробництва (робочі лінії, контрольовані операторами) до повністю автоматизованого виробництва потрібні промислові роботи, розміри яких аналогічні анатомії людини.

**Аналіз останніх досліджень і публікацій.** Поточне виробництво роботизованих пристроїв досягає високого технічного рівня, який ще більше посилюється внаслідок постійного розвитку їх підсистем, а також за рахунок поновлення функціональних принципів і елементів, які беруть участь в архітектурі та морфології вказаних пристроїв.

**Постановка завдання.** Механізований або автоматизований процес роботи залежить також від рівня роботи використовуюваного обладнання. На сучасному етапі розвитку проектування автоматизованого пристрою також повинно бути автоматизованим.

**Виклад основного матеріалу.** З погляду підходу до розробки робототехнічних систем можна зробити висновок, що загальною ознакою є мехатронний підхід. Робототехнічні пристрої – це типовий продукт з усіма функціями мехатроніки (зв'язує знання техніки, методів управління і штучного інтелекту). Це стає відправною точкою для розробки методів проектування роботів взагалі.

**Висновки.** Стаття присвячена розробці пристроїв робототехніки, основним завданням яких є виконання складання. Майбутнє використання співробітництва між людиною і роботом має величезні межі і безліч змінних, які необхідно розглянути. Важливо пам'ятати, що запропонована технологія не призначена для заміни людей роботами. Скоріше, йдеться про використання надійних характеристик людини та сил робота для досягнення нового рівня ефективності та продуктивності, які неможливо досягти окремо.

**Ключові слова:** промисловий робот; складання; робототехніка; виробнича дільниця.

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