Automation and Robotics in Construction XII
E.Budny, A.McCrea, K.Szymanski (Editors)

The Development of the Intelligent Multi-axis ALR Robots

P. Belohoubek [a], Z. Kolibal [a], Z. Kadlec [a], O. Vystrcil [b]

[a] Technical University of Brno, Institute of production machines and systems, Technicka 2, 616 69 Brno, Czech Republic.

[b] Research Institute of Construction Materials, Hnevkovskeho 65, 617 00 Brno, Czech Republic

Abstract

The paper describes the development of the special industrial multi-axis anthropomorphic angular robots, of ALR type - their design, computer control and the Intelligence. Human interaction and the robot control versus management control (the management factory control) are also addressed.

At The Institute of Production Machines and Systems (before Department of Production Machines and Industrial Robots) of the Technical University, Faculty of Mechanical Engineering in Brno, the development takes place of the special robots based on the series of the Cartesian portal type robots PRKM , the Cartesian bridge type robots PRM and multi-axis robots type ALR. The robots ALR type have 6 DOFs with rotational type of joints, where robot ALR-1 and ALR-2 are of modular unit-build design. Robots ALR-3 and ALR-4 have the simple self balancing systems of the orientation mechanism.

1. The Design of the Industrial Anthropomorphic Robots ALR-4 Series

This series is still in the preparation stage and the main features can be summarized as follows:

- light weight series of robots,
- 4 dimensions after geometric series with q = 1.4,
- 4 nominal weights (2.5 - 20 kg) after geom. series with q = 2,
- for the interior robot work , the preparing work as the robot welding, painting, grinding, manipulation etc.

Table. 1 The Anthropomorphic angular type robots ALR series

Series of robots	ALR 4.2	ALR 4.3	ALR 4.1	ALR 4.4
max. height reach [m]	**1.2**	**1.6**	**2.2**	**3.0**
nominal weight [kg]	**2.5**	**5**	**10**	**20**

At the same time has been developed and is in production, the anthropomorphic robot ALR-4.1 (AC servomotors, PC control, etc.) at TU Brno and at Research Institute of Construction Materials Brno (VUSH Brno).

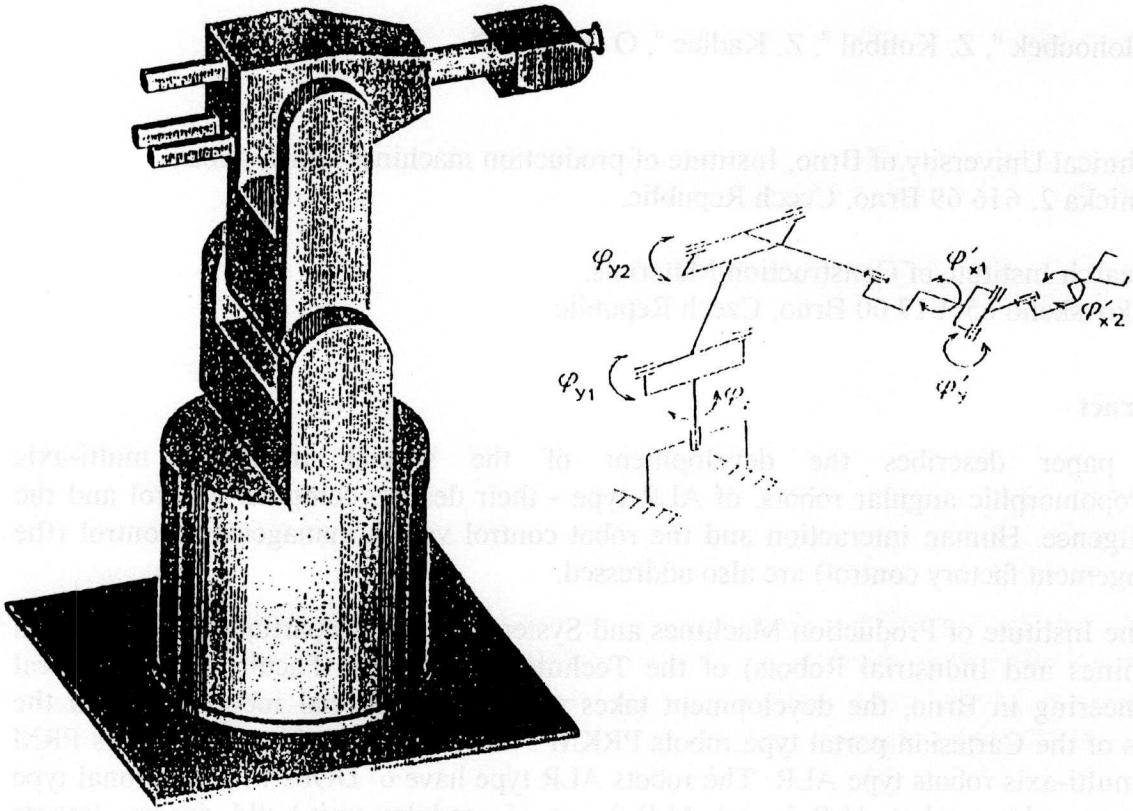


Figure 1. The anthropomorphic industrial robot ALR-4.1

2. The Development of the Industrial Robots AHR Series

This series is also at the development stage. Anthropomorphic angular heavy robots AHR series - for nominal weight 50 - 200 kg (for nuclear power plant, post-disaster aid, for use in the construction etc.).

The development of the AHR robots will continue from the robot series ALR, especially from the biggest robot of this series ALR-4.4. The direction of the design will be towards heavy weights, therefore, for some applications it will be with the hydraulic drives and the telescopic arms etc.

3. The Development of the Anthropoid Robots ABR Series

This series includes lightweight of anthropomorphic angular bio robots - ABR series (for the replacing of human arms, legs etc.) The development of the ABR robots will continue from the robot series ALR and from the smallest robot from this series ALR-4.2.

The development of the ABR series is based on the modular design of the robot ALR-1 (the model of the human arm - but with the heavy weight servo-drivers - stepping motors).

4. The Computer Control of the 6 DOF Robots

The analysis, the synthesis, the additional movement function and the robot movement simulation together with the robot movement model have been developed in C++ language and is used for the robot movement graphic simulation. This model is prepared for the robot control using active virtual reality software and in the future will become part of the intelligent robot control (for example, to avoid the obstacles etc.). It will also be used for the real modelling and training of the ALR robots in the building environment.

5. The Data Transformation from the Robot Design and Robot Workplace Using AUTOCAD to Robot Movement Model in C++.

Body of the robot and robot workplace are drawn to the different layers of AUTOCAD. Format DXF is being used for the data transfer. The data transfer program is in C++ language.

6. The Computer Control of 6 Servomotors with Synchronous Motors.

The development of the intelligent autonomous servomotors control and the communication in the real time enables the results to be used in the intelligent robot control systems, the management control etc.

7. The Computer Aided Design of the Kinematics Chains of the Industrial Robots.

Depending on the robot workplace and the robot movement trajectory, the evaluation of robot's kinematic chain suitability takes place. It is necessary for coordination between the Robot CAD/CAM and Robot CIM systems.

8. Preparation of the ALR Robot Applications in the Industry:

a) In the civil engineering and the building industry: especially for preparation work and the interior finishing activities, such as assembly, manipulation, painting, welding, grinding, etc, .

b) In the mechanical and electrotechnical industry: during the assembly, welding, grinding, etc,.

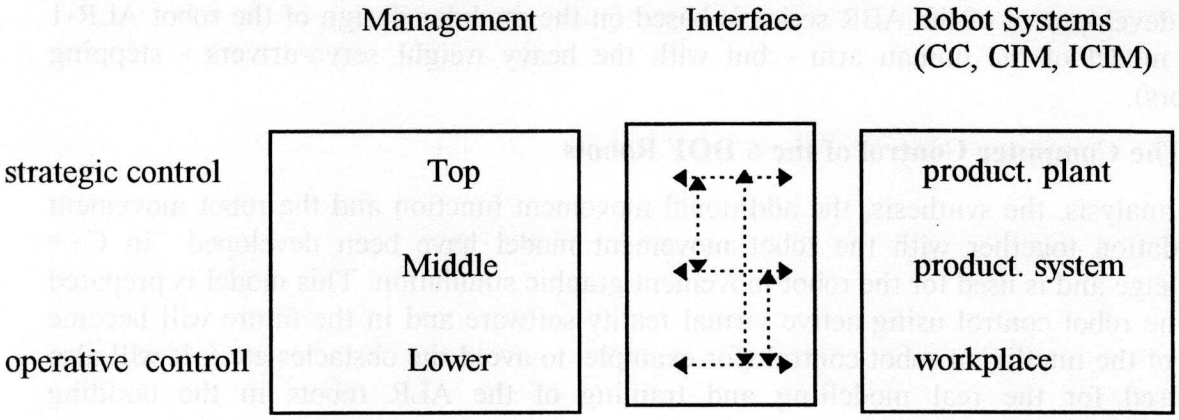
c) For future medical application (especially the ALR and ABR robots).

9. Using the Intelligence at the Management Control and Robot System Control .

a) The design of the more level LOGISTIC model of the factory in the relation to the quality control systems.

b) The relation between the Computer control of factory and Management control of factory.

c) The interaction between humans, computers and robots.



CC .... Computer Control

CIM ... Computer Integrated Manufacturing

ICIM... Intelligent CIM

Interface: a) For the interaction : vision, voice, hearing, touch, the bio-signals etc.

b) Using of human bio-factors, physiology, ergonomy, psychology, sociology etc.

Figure 2 Using of the intelligence for the interaction of the management control and robot control.

10. Conclusions

Researches in many fields are connected together and the results from one field can be used in another. For example at the design of production machines, robots can be applied. In the field of the application of robots, on the other hand, mechanical engineering and civil engineering are an example. Computer aided design, computer control and management control show the application of electronics and mathematics.

The above tasks are worked on in the state research for the Grant Agency of Czech Republic under the topic „The Computer Control and the Design of the Multi-axis Robots".

References

[1] Belohoubek P. - Kolibal Z.: The Development of the Computer Control of the More Axis Robots in the Relation to the Robot Workplace projection in AUTOCAD. International Symposium Paragraph 94, Hagenberg, Austria, 1994.

[2] Belohoubek P. : Zamereni výzkumu inteligentnich systemu v oblasti robotiky a managementu podniku v ramci statniho ukolu Rizeni a stavba viceosych robotickych systemu. (The direction of the intelligent systems research on the field of the robotic and the factory management in the state research task The Computer Control and the Design of the More Axis Robots). Seminar ICB, Brno, 1994.

[3] Belohoubek P.: The Using of the LOGISTIC at the Projection and Application of the Robot Welding Work Systems. 5th International DAAAM Symposium. Maribor, Slovenia, 1994.

[4] Belohoubek P.: Research in Computer Aided Robot Design in relation to the Virtual Reality. International WORKSHOP SPECIALIZED DESIGN SCIENCES (S D S) , PILSEN, Czech Republic, 1994.

[5] Kolibal Z., Belohoubek P., Holec P., Vystrcil O.: Modularity of PRM type cartesian robots and their application in the production of construction materials. 11th international symposium on automation and robotics in construction (ISARC), Brighton, U.K., 1994.

[6] Kolibal Z., Holec P.: Grippers for adaptive robotic assembly, Intl. conference 9th ISARC, Tokyo 1992, Japan

[7] Kolibal Z.: Das robotisierte Umladesystem des Montageautomaten in der Massenproduktion, 4th Intl Symposium DAAAM, Brno, 1993.

[8] Kolibal Z.: The automatic measuring in the robotized manufacturing system. 5th International DAAAM Symposium. Maribor, Slovenia, 1994.