

## SCIENTIFIC LIFE

### THE FIRST BULGARIAN INDUSTRIAL ROBOT “PROBO” 1987

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**ABSTRACT.** The paper presents the first Bulgarian industrial robot “PROBO” build up entirely on elements, tools and human efforts at the former “Precision mechanics” laboratory within the Bulgarian Academy of Sciences. The robot was publicly demonstrated at Plovdiv exposition in 1987. The place of the robot in the world timeline is shown. A definition of “robot” is proposed, as well.

**KEY WORDS:** First Bulgarian robot, definition of robot, robot control system.

#### 1. Robot definitions

The development of robotics as a science began relatively soon, after 1970. Robotics, as a science, is looking for the best definition of the term “robot”, for example:

**ROBOTICS INSTITUTE OF AMERICA:** A reprogrammable, multifunctional manipulator designed to move material, parts, tools, or specialized devices through various programmed functions for the performance of a variety of tasks.

**ENCYCLOPEDIA BRITANNICA:** A robot is any automatically operated machine that replaces human effort.

**INTERNATIONAL STANDARD ORGANIZATION:** An industrial robot is an automatically controlled, reprogrammable multipurpose manipulator, programmable in three or more axes.

**MASSACHUSETTS INSTITUTE OF TECHNOLOGY:** A robot is something that has some physical effect on the world, but it does it based on how it senses the world and how the world changes around it.

WEBSTER DICTIONARY: A robot is something guided by automatic controls that automatically performs repetitive tasks.

WIKIPEDIA: A robot is combined electro-mechanical computer system that performs physical and computational activities.

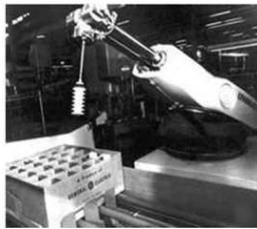
Analyzing the many definitions of the term “robot”, we suggest the following:

OUR DEFINITION: ‘Robot’ is a machine that operates under automatic control aiming to perform goal-oriented actions.

## 2. Timeline of robots

Robotics as a practice marks a rapid development after 1961, when the world’s first industrial robot, known as UNIMATE, has been installed.

The next well known industrial models of robots as Stanford Arm, Puma and Scara appear within two decades.



UNIMATE (1961)



STANFORD ARM (1969)



PUMA (1978)



SCARA (1981)

The first Bulgarian industrial robot “PROBO” was designed, fabricated and demonstrated in 1987. Mechanics, electronics and control system were fully developed in former laboratory “Precision Mechanics” with the Bulgarian Academy of Sciences.



PROBO (1987)

The demonstration of the robot "PROBO" took place during PLOVDIV EXPOSITION 30 October – 15 November 1987 and is shown in Fig. 1.



Fig. 1. Plovdiv exposition 30.10-15.11.1987

The kinematic structure and the working area of "PROBO" are depicted in Figs 2-4.



Fig. 2. PROBO 1987

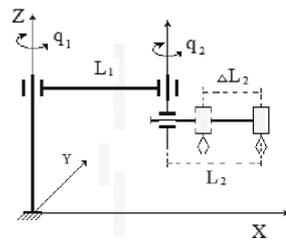


Fig. 3. Kinematic structure

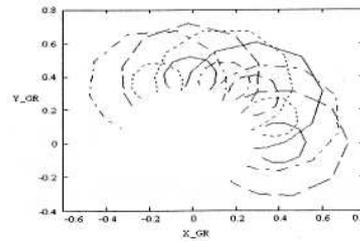


Fig. 4. Working area

The control system is presented in Fig. 5.

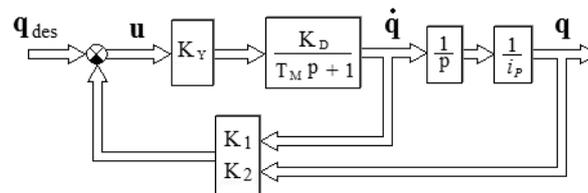


Fig. 5. Control system

The control algorithm was based on the state space control system theory [1, 2]:

$$\begin{aligned} \dot{\underline{x}}(t) &= \mathbf{A}\underline{x}(t) + \mathbf{B}\underline{u}(t) \\ \underline{y}(t) &= \mathbf{C}\underline{x}(t) \end{aligned} \quad , \quad \mathbf{A} = \begin{bmatrix} 0 & 1 \\ 0 & a \end{bmatrix}, \quad \mathbf{B} = \begin{bmatrix} 0 \\ b \end{bmatrix}, \quad \mathbf{C} = [ 1 \quad 0 ],$$

$$a = -\frac{1}{T_M}, \quad b = \frac{K_D K_Y}{T_M i_P}$$

$$\underline{x}(t) = \begin{bmatrix} q(t) \\ \dot{q}(t) \end{bmatrix}, \quad \mathbf{K} = \begin{bmatrix} K_1 \\ K_2 \end{bmatrix}, \quad \underline{u}(t) = -\mathbf{K}\underline{x}(t),$$

where  $T_M$ ,  $K_D$ ,  $K_Y$ ,  $i_P$  are known driving system parameters.

### 3. Conclusion

A definition of a robot is proposed. In the timeline of world industrial robots the place of the first Bulgarian industrial robot "PROBO" is shown. Information about kinematic structure, working area and elements of the control system are given. The robot was publicly demonstrated at the Plovdiv exposition in 1987.

### REFERENCES

- [1] PATARINSKY, S., V. DENEV, G. V. TZVETKOVA. Manipulators Control System Design via Successive Simulations. Proc. of Int. Symposium on Simulation of Control Systems, IMACS, North-Holland Publishing Company, 1978, 305–309.
- [2] TZVETKOVA, G. V. Modelling of Transport Operations for Industrial Robots, Anniversary Scientific Conference 10 Years NIIR, Stara Zagora, 1987, 216–221 (in Bulgarian).