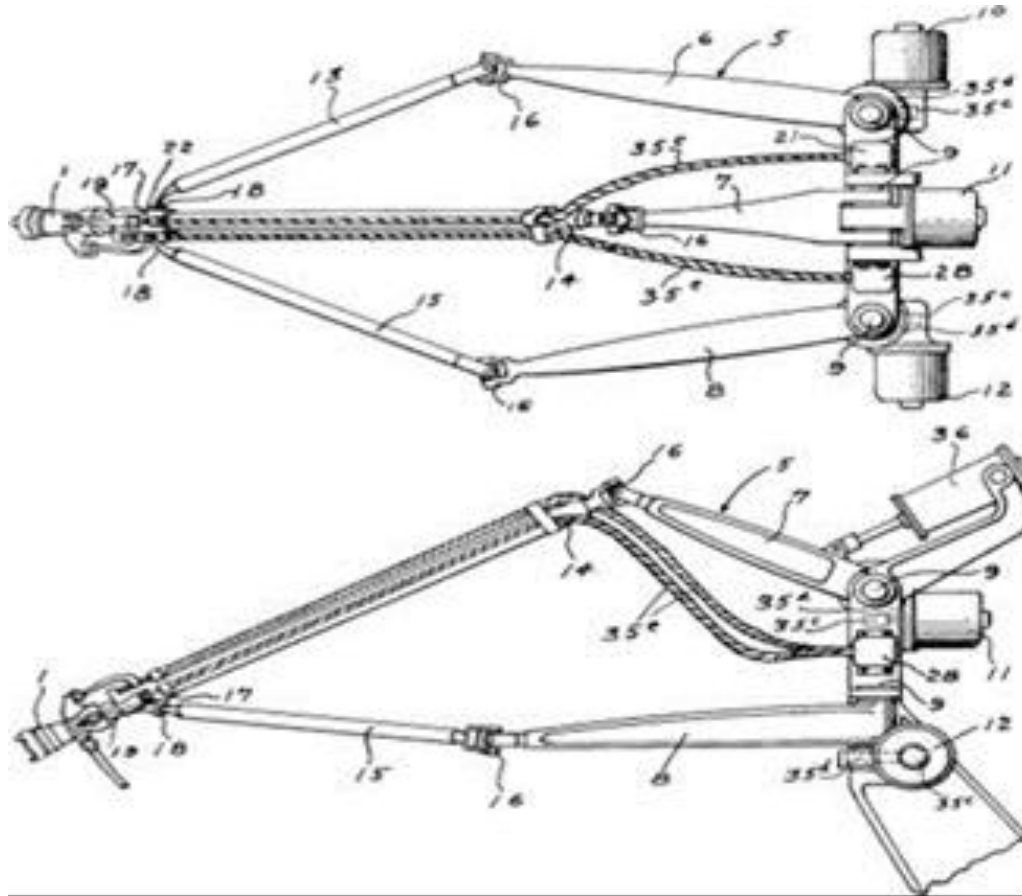


# Развитие робототехники

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# Начало развития



- ▶ Первый робот-манипулятор

# Протороботы

0.G

## Pre-Robots

- The first industrial robots were pneumatic or hydraulic.

1.G

## Manipulators

- Telemanipulator (1950)
- NC Manipulators (1960)
- No environment information.
- Movement described from point to point.

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- 1495 • **Leonardo da Vinci** sketched of a mechanical knight, which could sit up and move its arms and legs, is considered to be the first design of a humanoid robot [1].
- 1725 • **Punch Card**, a piece of stiff paper that can be used to contain digital information represented by the presence or absence of holes in predefined positions. The information might be data for data processing applications, used to directly control automated machinery [2].
- 1943 • **Colossus**, the first programmable electronic computer [3].
- 1948 • **Transistor**, a breakthrough for electronics, a key element in the development of semiconductors, such us microprocessors [4].
- 1950 • **Digital Computer** [5]/ **NC Numerical Control** [6]: The basis of the next years of robotics.
- 1952 • First prototype of **numerical control machine** with APT (Automatically Programmed Tool), the first programming language. ATP, it is a high-level computer programming language most commonly used to generate instructions for numerically controlled machine tools [7].
- 1959 • First computer controlled machining tool. The logic was still implemented by wiring [8].
- 1961 • **UNIMATE, digitally operated and programmable robot** - mechanical arm, based on numerical control. Those who allowed the first production line with robots, General Motors [9].
- 1963 • **Integrated circuits**, the entry in the microelectronics world, so the automation race was on [10].

# Сенсорные роботы

2.G

## Robots with sensorized control

- More aware of their surroundings.
- Advanced sensory systems: touch, vision etc.
- Learn and memorize the desired sequence of movements through monitoring the movements of a human operator.
- Generally, this type of robots is used in the automotive industry and are large in size.

- 1968 ● **SHACKY**, first sensorized and mobile robot ("intelligent" robot) provided with a diversity of sensors as well as a vision camera and tactile sensors. Developed by Stanford Research Institute [11].
- 1968 ● PLC (Programmable Logic Controller) is an industrial digital computer which has been ruggedised and adapted for the control of manufacturing processes, such as assembly lines, or robotic devices, or any activity that requires high reliability control and easy of programming and process fault diagnosis. Its becomes the most used device for automation [12].
- 1971 ● The 4-bit microprocessor is manufactured by INTEL Corp. They have offered a "brain" to the muscles of mechanical robots [13].
- 1971 ● **IRB 6 robot**, Fully electric drive robot [14].
- 1973 ● **WAVE**, first experimental language for robot programming research applications at the Stanford Artificial Intelligence Laboratory [15].
- 1973 ● **KUKA Famulus**, world's first industrial robot with 6 axes powered by electric motor [16].
- 1974 ● **T3 robot**, the first commercially available microcomputer controlled robot was introduced by Cincinnati Milacron (acquired by ABB in 1990) [17].
- 1974 ● **AL (Assembly Language)** the successor of WAVE, illustrates the factors that have to be considered for flexible control of mechanical manipulation [18].
- 1977 ● **R2-D2 and C-3PO** Star Wars films. The plucky androids are arguably the best-known robots in modern culture. This science fiction robots have inspired the robotic development [19].

# Промышленные роботы

## 3.G Industrial robots

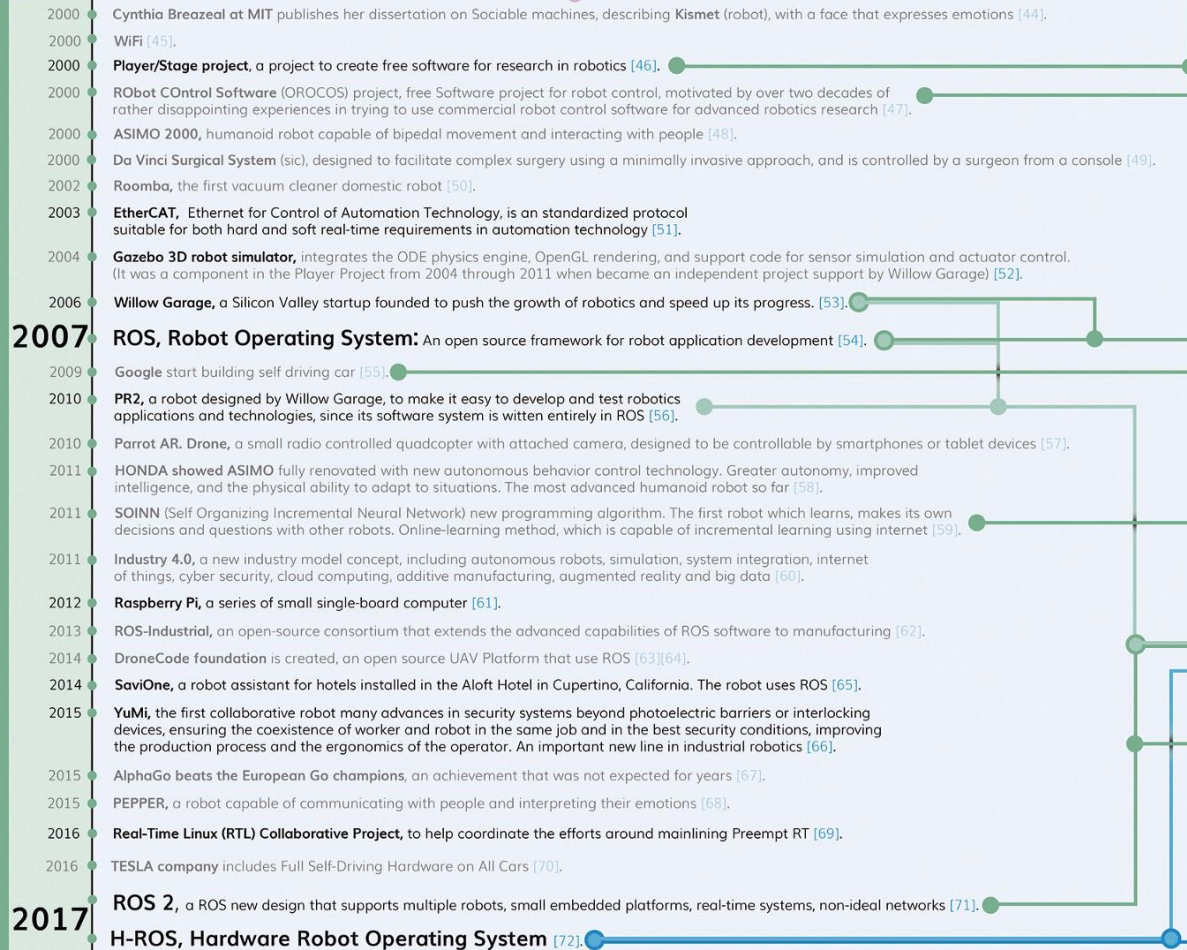
- The robots now have controllers (computers).
- New programming languages to write robot control programs.
- Reprogrammable robots.
- Artificial vision is partially included.

- 1979 • VAL, first programming language (based on WAVE and AL) to be designed and implemented in industrial application for the Unimate robot [20][21].
- 1980 • **FIRST YEAR OF THE ROBOTIC ERA** (production of industrial robots increased more than 80% when compared to the previous years) billions of dollars were invested by companies to automate basic tasks in their assembly plants [22].
- 1980 • General internet access is extended [23].
- 1980 • The first Beckhoff control equipped with a hard disk. The simplest solution was to integrate a PC. It soon became apparent that the PC could do more than act as a data collector for the control system, and the era of PCs in the automation industry started [24].
- 1983 • Ethernet becomes a standard as IEEE 802.3, is the standard way to connect computers on a network over a wired connection [25].
- 1984 • Flakey robot, builded based on Shakey but adding the technological advances of the moment, including on-board computers to run its behavior algorithm [26].
- 1987 • International Federation of Robotics was founded in Stockholm (Sweden) [27].
- 1988 • KAREL, robot control language used by FANUC [28].
- 1989 • V+, real-time and multitasking operating system from ADEPT, manages all system level operations, such as IO, program execution, task management, memory management and disk file operations [29].
- 1989 • Generic Robotic Processing Architecture (GRPA), high level robotic control and integration architecture designed to provide a flexible, standard interface between users and a wide variety of robotic processing system [30].
- 1989 • Genghis, a small six-legged robot that can walk, climb over obstacles, and follow people [31].
- 1991 • Linux KERNEL, a Unix-like, open source and community-developed operating system for computers, servers, mainframes, and later, mobile devices and embedded devices [32].
- 1993 • Pentium, fifth generation microprocessors, With more than  $3^{10}$  transistors [33].
- 1994 • RAPID, is a high-level programming language used to control ABB industrial robots [34].
- 1996 • Linux Real-Time patches (PREEMPT\_RT), a soft real-time patch makes possible to control robots, data acquisition systems, manufacturing plants, and other time-sensitive instruments and machines [35] [36].
- 1997 • Integration push: Automation technology increasingly consists of decentralized and intelligent control and components that can communicate with each other via industrial Ethernet [37].
- 1997 • Digital Factory and Virtual Commissioning: The world of digital product development merges with automation technology. Control programs for production processes are developed based on simulation [38].
- 1997 • Artificial intelligence: IBM's "Deep Blue" supercomputer wins the world chess champion, Garry Kasparov [39].
- 1997 • Mars Pathfinder, the robot designed by the NASA, lands on Mars and makes several scientific testing with different technologies [40].
- 1998 • LEGO Mindstorms, a kit consisting of 717 pieces and intelligent brick computer (with an embedded microprocessor) that controls the system, a set of modular and interoperable sensors and motors to construct different robots [41].
- 1998 • JAUS (The Join Architecture for Unammed Systems), a standard messaging architecture enabling communication with a control of unmanned systems [42].
- 1999 • AIBO, first toy/research robot, Sony brings robotics to everyone [43].

# Умные роботы

## 4<sub>G</sub> Intelligent robots

- Included advanced computers.
- Artificial intelligent is included.
- These computers not only work with data, they can also carry out logical reasoning and learn.
- More sophisticated sensors that send information to the controller and analyze it through complex control strategies.
- Adapt and learn from their environment using "diffuse knowledge", "neural networks", and other data analysis and retrieval methods to improve overall system performance in real-time.
- The robot can base its actions on more solid and reliable information.
- Collaborative robots are introduced.



# Персональные роботы

5.G

## Collaborative and personal robots

- Robots working with humans in the same environment.
- Reconfigurable robots.
- Robots enhancing human capabilities on daily activities.
- Modular robots.

- 2019 ● **Robots in most factories**, the robots will do all the mechanic and repetitive works, also the most of the warehouses will be automated.
- 2020 ● **Robot companions**, robot pets, educational robots (e.g. robots to learn languages), ...
- 2021 ● **Intelligent factories**, most of factories, including small companies, will rely on intelligent robots.
- 2022 ● **Robot exoskeletons**, frames that enhance human capabilities.
- 2023 ● **Robot assistants**, robots to guide, help, answer questions, collect data, recognize and empathize with humans in restaurants, stores, clinics, schools, gyms etc.
- 2024 ● **Self-driving cars** in cities.
- 2025 ● **Domestic robots**, different gadgets that free the user from basic household tasks.
- 2027 ● **Food robots**, robots that cook food completely autonomously.
- 2028 ● **Generalized search and rescue**, robots that collaborate with humans in rescue and assistance tasks.
- 2030 ● **Autonomous public transport**, taxis, buses, trains, planes...
- 2032 ● **Security robots** inside urban areas.
- 2033 ● **Drone delivery**, packages deliver directly at home in a few hours.
- 2035 ● **Autonomous medical robots**.
- 2040 ● **Eldercare robots**, robots that in addition of taking care of and helping, provide the correct medication, detect irregularities and act appropriately.

# Будущие разработки и идеи

- 2020 – Модульный подход к проектированию роботов
- 2024 – Полная автономность личного транспорта
- 2028 – Новейшие медицинские микроботы
- 2032 – Андроиды со способностями идентичными человеческим
- 2036 – Освоение роботами 49% специальностей

*На основе: <http://robotrends.ru/pub/1638/perspektivy-razvitiya-robototekhniki-do-2040-goda>*



# Технология H-ROS

- Разделение компонентов робота на «модули»
- Plug & Play
- Операционная система с открытым исходным кодом
- Приведение проектирования роботов к единому стандарту

*На основе: <http://robotrends.ru/pub/1644/h-ros-unificiruet-i-standartiziruet-moduli-dlya-robotov>*