Prospects for Establishment of Technological Complexes in Machine Building Industry on The Basis of Electromechatronic Propulsion Systems

Yu M Osipov [1, 2, a], O Yu Osipov[2, b], V A Trifonov [1,c]

[1]Yurga Technological Institute (affiliate) of National Research Tomsk Polytechnic University, Russian Federation, 652055, Kemerovo region, Yurga, Leningradskaya str., 26
[2] National Research Tomsk State University, Russian Federation, 634050, Tomsk, Lenina ave., 36
[a] e- mail: umo1943@yandex.ru, [b]e-mail: ems2009@mail.ru,
[c] e-mail: v.trifonov@rambler.ru

Abstract. The authors consider prospects for technological complex establishment in machine building industry on the basis of electromechatronic propulsion systems for production of innovative products with different novelty levels: world, state, brunch, region, etc.

Nowadays there are many areas where people use robots and manipulation mechanisms. Among them there are both robot machines of Emergencies Ministry for saving people's lives (they are able to find a person under ruins, destroy a bomb, or check nuclear power plant after an accident), and robots for our daily life irrespectively of their specialization.

In comparison with strong gains in robotics intelligent control in technological complexes engineering achievements, which concerns creation of their basic elements such as final control elements of manipulator and robot movements, are far from perfect. This is the main component of robotic tools in any technological complex of machine building industry, where end-effector movements are done.

In the majority of Russian and foreign robot manipulators, in very many cases automated hand (lag) joints are single-axles with reduction electric drives, which are the source of noise, low speed, inaccuracy due to drive shafts, gear belts, gear trains, etc.

A robot construction needs till nine single-exle joints to move, for example, a hand (shoulder, fore arm, etc.) in a thee axes system. It creates big constructions, needs difficult control procedures of multicoordinate stage movements. To decrease influence of enumerated factors they decrease gearing burden, design rational robot configurations, certain contours, limit working space, etc.

It is proved by modern research and development situation in many companies: Fanuc Ltd., Yaskawa Electric Corp., Fuji Machine Mfg. Co., Toshiba Machines Co., Okuma Corp., MoriSeiki Co., Makino Milling Machines Co., Hitachi Seiki Co: Japan, Broetie-Automation GMBH, Germany, TSNIIPTK, Russia, etc.

Nowadays there are many interesting ideas and inventions that concern traverse actuators of robot moving parts, which are still in concepts or prototypes. They will be robotic tools tomorrow [1-6].

Today modern technological complexes of machine building industry on the basis of robots and manipulators represent development needs and social production improvement as a base for economical and military technical state power. They also represent necessity for research and assimilation of new alternative fields and spheres for people's activity.

The authors study electromechatronic robot and manipulator components, which are driven by electric drills, have operation and control sections. Progress in microprocessor technology sphere, electronics, and computing machinery has made possible to expand functions and quality of electric drill control sections, which are almost perfect now. There is no further development of control sections, robots and manipulators in general without qualitative development of operation parts, what lowers their quality and competitive ability [7, 8].

Very actual developments are those that are aimed at robot and manipulator operation parts creation with advanced control sections, which provide integrated move of every part of a robot set, for example, an arm (a shoulder, a fore arm and a hand), with movement characteristics that are similar to real man's movements (from soft, creeping speeds till abrupt movements adapted to an event) with assimilation of difficult and adequate movements. There is a new design tendency in mechatronics that is why constructional decisions become easier: they remove drive units, cam gears, conversion devices for transformation of roll motion into prismatic motion, etc. New magnetic materials on the basis of rare earth metals, new electrotechnical and constructional materials define electromechatronic development and provide usage of electric drill of private action in designing operation parts for technological complexes of machine building industry, consumer electronics, medicine, etc. It is possible to progress by synergetic joining nods of electrical machines with mechanical, electronic and computer components. It ensures production of whole new units – electromechatronic modules (EMD) and electromechatronic movement systems (EMMS) with intellectual control.

The authors propose to develop technological complexes of machine building industry on the basis of new functional element that is "active" driveline (ADL), which provides integrated movement of every part in a robot set, for example, an arm (a shoulder, a fore arm and a hand), with movement characteristics that are similar to real man's movements (from soft, creeping speeds till abrupt movements adapted to an event) with assimilation of difficult and adequate movements [9].

The results of Research and Development (see Table 1).

1. The authors formed the conception of intellectual scheme-constructive design – synergetic integration of electromechanical, electronic and computer control units, as a result of which people have innovations: industrial objects with different protection levels (world, state, branch, region, etc.) involved in commercial turn-round. Theory basis and principles for EMD and EMMS formation are done in the monograph "Multicoordinate electromechatronic movement systems" of the authors O.Yu. Osipov, Yu.M. Osipov, S.V. Shcherbinina:

- methodology for intellectual scheme-constructional design: in innovation processes realization of information conversion and energy in the system "person – tool – work object – environment" with the help of worker intellectual-creative resources on the basis of their educational knowledge, including their heuristic and creative thinking, metadata of design intellectual systems, synergetically integrated electromechanical, electronic and computer control units, as a result of which people have innovations: industrial objects with different protection levels (world, state, branch, region, etc.) involved in commercial turn-round;
- mathematical models and logic for interconnected space movements of joint groups on an "active" driveline (ADL), for example, for an assembly manipulator or an automated "arm" of a manipulator robot;
- systems of accumulator electric power supply and management of ADL voltage (24÷27) Volt with possibility to put some components of electric power supply and control in constructions of mobile robot sets, including robot arms (legs) and body;
- methods to calculate magnetic discontinuity inductive capacity and electromagnetic moving forces of ADL with power active core piece;

- methods for automated forecasting of EMD large, force-torque and speed characteristics to coordinate order production;
- automated technologies for display of inductor and EMD rotor core pieces;
- systems for automated documentation design for mobile robot sets with joints on the basis of ADL.

Table 1

R&D of electromechatronic movement systems

№	Research and Development of units with electromechatronic movement systems	Time periods (years)
1.	R&D «Development and making an experimental model of isolated generating plant with photovoltaic panels, automatically oriented to the Sun».	2010÷2011
2.	R&D «Development and making experimental prototypes of a high accuracy positioning system for X-ray microbarograph to study material patterns of organic and inorganic nature».	2010÷2011
3.	D «Development and making experimental prototypes of positioning mount to study antenna characteristics».	2011÷2012
4.	D «Development and making a device for nondestructive quality control of heating unit production and calibration».	2012÷2014
5.	R&D «Scientific-technical basis development of multicoordinate electromechatronic movement system formation for robotic tools on the basis of a functional unit that is an “active” driveline».	2013÷2014

2. The authors developed construction documentation for a range: arc EMD (Figure 1), line EMD (Figure 2), rotating EMD (Figure 3).

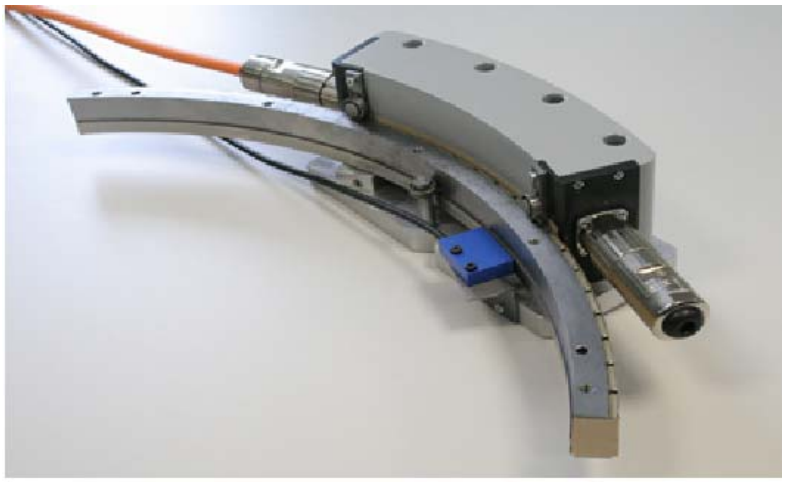

Figure 1. General view of arc electromechatronic module of movement

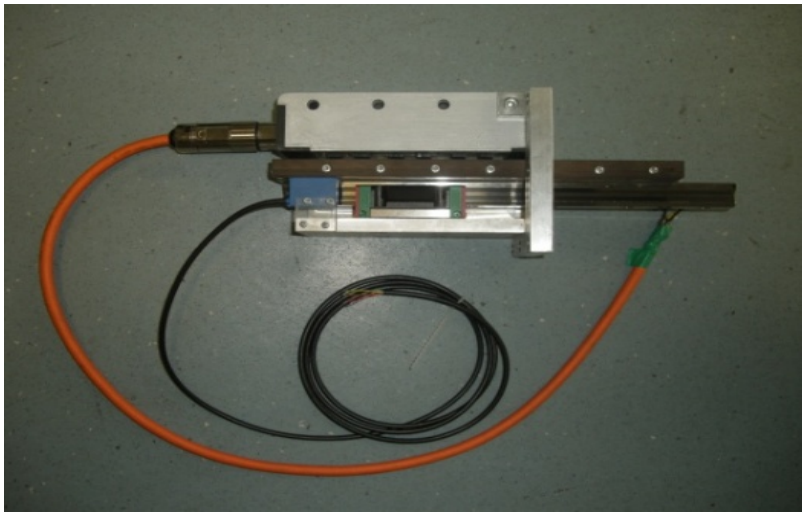

Figure 2. General view of line electromechatronic module of movement

Figure 3. General view of rotating electromechatronic module of movement

On the basis of developed element base the authors made experimental and small-lot prototypes of robotic sets and integrated in technological complexes of client machine building industry: positioning mount to test antennas of Radio Detection and Ranging equipment, device for nondestructive quality control of heating unit production, etc.

3. The authors presented a scheme-constructive conception of a new functional element, segment joints of robotic tools that is active driveline (ADL), which can help obtain advanced results in movement characteristics of robotic tools that are similar to real man's movements and provide integrated move of every part of a robot set, for example, an arm – from soft, creeping speeds till abrupt movements adapted to a real event, with assimilation of difficult and adequate movements especially in extreme and extraordinary situations.

The authors designed some constructive variants of ADL. For an experimental prototype they selected the variant that had design advantages: bigger rotary traverse of an output element in comparison (about 125h180 degree); possibility to put feedback probes and electromagnetic breaks without increasing a structure gauge; operational integrity of electrical wire of power supply and feedback by means of fixed arc inductors.

Main theories and principles for ADL formation are done in the article “Creation of extreme robotic sets on the basis of an active driveline” [9].

The authors made a joint of a robotic set on the basis of a new functional element that is an “active” driveline. The joint with radar antenna was tested in situ at a scanner assembly (Figure 4).

Figure 4. General view of a joint of a robotic set on the basis of a new functional element that is an “active” driveline with radar antenna

R&D in 2010÷2014 and developed scientific-technical work (scientific publications, monographs, RF patents, constructive-technical documentations, software support, etc.) allowed the authors to summarize experience and formulate some ways for establishment of technological complexes in machine building industry on the basis of electromechatronic movement systems for the next period till 2020 according to two R&D directions:

Products to achieve economic growth of a country.

1. Worktable manipulator of a laser beam machine for working spherical and curved surfaces, holes, etc., which has a working detail (or an article) with angle indexing in three rectangular axes.
2. Therapeutic training device with application of energy from impulse low-frequency electromagnetic field, thermal field and mechanical field to influence the zona of small pelvis and back bone with some manipulations (vibratory massage, medicine + infrared light).
3. X-ray 3D tomographic scanner to study substance structure of organic and inorganic nature, and for nondestructive product control.

Products to provide safety and defense capacity of a country.

1. Compact hybrid electromechatronic inertial navigation system for no-maintenance mobile objects.
2. Compact electromechatronic computer for mobile object position, for example, an unpiloted deep research vehicle.
3. A robot-android with remote intelligent control for rescue operations and so on.

Conclusion

1. During developing robotic tools of technological complexes for machine building industry scientists have to solve a compromise problem where the stress is made either on an operation or

control part. The level of techniques, which are used in formation of an electromechatronics operation or control part, plays a certain role in compromise decision selection.

2. Theory and methodology base of robotic systems with new type joints will have principles of construction integration and combination of electromechanical, electrical, electronic, and computer components, technologies for balancing moving parts and assembly of inductor cores and energy active rotors, optimization of magnetomotive construction force of passive and active core pieces and there components, windings, etc.

3. Active driveline application will allow obtaining new results in characteristics of robotic tool movements, which are similar to real man's movements (from soft, creeping speeds till abrupt movements adapted to a real event).

4. Originality of proposed ways for scientific problem solving shows practicability of theoretical and experimental researches, possibility to get results that have a right to be protected as inventions, utility models, production prototypes, application software, database, know how.

5. Importance and ranking of project results in a state safety related system with project results realization are extremely high: increasing of a state alert level till 2030, including antiterrorism protection, defense problem solving, fire fighting, space and World ocean exploration, problems of nuclear energetic and hazardous production facilities, medicine.

6. Technological development forecasting (project results will allow going the next step) is to design robotic tools with EDM with flexible controlled core pieces, which have high tactile sensitivity and sensor properties.

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