INTERNATIONAL PATENT RESOURCES IN THE STUDY OF INNOVATIVE TECHNOLOGIES (AT THE EXAMPLE OF GLONASS/GPS)*

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ABSTRACT

In the work presented by the authors using the international patent resource Qustel-Orbit, the state of innovative activity and patenting in the field of satellite navigation GLONASS/GPS was revealed for the entire period of patenting of inventions in the world until 2014. Inventions based on the use of GLONASS/GPS systems have a wide range of practical applications. In the area under consideration, the largest number of patents is published in China, the United States, and Korea. In this row, Russia occupies the eleventh place. The positioning of patent owners was carried out according to the indices of relative similarity and with the stage-by-stage processing of information according to a given algorithm.

* Final part of the articles covering the subject. See *World of Transport and Transportation Journal*, Vol. 14, Iss. 5, pp. 112–126.

Keywords: patent resource Qustel-Orbit, FIPS, innovative technologies, satellite navigation, GPS, GLONASS, system analysis, patent owners.

Background. *Based on the analysis of the areas of patenting of GNSS / GPS technologies, the positioning of patent holders was carried out in terms of relative similarity of names and the number of areas in which patent holders-organizations patented inventions on the territory of Russia.*

Objective. *The objective of the authors is to consider international patent resources in research of innovative technologies development, using GLONASS/GPS samples as an example.*

Methods. *The authors use general scientific methods, comparative analysis, statistical method, evaluation approach, graph construction.*

Results.

Positioning algorithm

The method of positioning of patent holders is based on stage-by-stage processing of information according to the following algorithm.

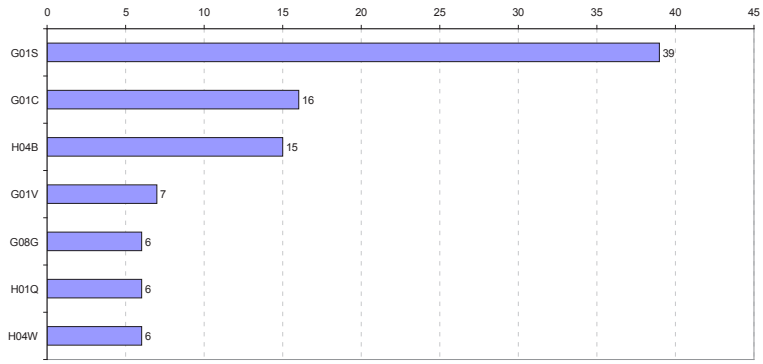
Stage 1. *Defining the scope of research and searching for patents in databases.*

The identification and analysis of the areas of patenting of GNSS / GPS technologies by domestic and foreign organizations was carried out on patents published in the territory of Russia in the last ten years. A selection of patents was carried out using the patent resource Questel-Orbit and the system of the Federal Institute of Industrial Property (FIPS) [1, 2]. 236 patents have been revealed. During the analysis, for each of them, the year of publication, class, subclass, group and subgroup of the International Patent Classification (IPC), the patent owner, the scope of application and the technical result achieved – the objective of the invention have been recorded. All patent owners were divided into three groups: 1 – Russian patent owner organizations; 2 – foreign organizations-patent owners; 3 – patent holders – natural persons. A fragment of the preliminary systematization of patents is given in Table 1.

In Table 1, patent owners are ordered by classes, subclasses, groups and subgroups of IPC. This method of systematization shows potential competitors who patent GNSS / GPS technologies in the same patent classes, subclasses, groups and subgroups. Subclasses with the largest number of patent holders are shown in Pic. 1.

Based on the information summarized in Table 1, the total number of IPC classes patented on the territory of the Russian Federation can be established: classes – 29, subclasses – 63 (of which 50 cover organizations and 27 are individuals), groups – 116, subgroups – 194. For each class, subclass, group, subgroup, matrices of conformity with patent holders were established.

Matrix analysis showed that the range of coverage by individual organizations and individuals is: for subclasses – from one to eight, for groups – from one to twelve, for subgroups – from one to twenty-one. The range of coverage characterizes the level of diversification of organizations in various technological areas. The number of patent holders in one class indicates the importance and relevance of this direction. It can be considered as an indicator of the level of competition (scientific and technological and



Pic. 1. The number of patent owners in classes.

Table 1

Structure of preliminary systematization of patents

№ of patent/ publication date	Classes, subclasses, groups, subgroups	Name	Application area	Objective	Patent owner
2478049 2013	B60M3/00	POWER SUPPLY SYSTEM OF ELECTRIFIED AC RAILWAYS	The invention relates to the field of power supply of railways.	Establishment of an electric power supply system for electrified AC railways, which makes it possible to increase the accuracy of control over electric power consumption by electric vehicles by the movement, the condition of the track and the operating mode of the traction network and traction substations at the expense of control over the consumption of electricity by the electric rolling stock when moving along a separate section between adjacent traction substations of various power supply distances.	State Educational Institution of Higher Professional Education Far Eastern State Transport University (FESTU) (RU)
2446065 2012	B60M3/02	INFORMATION SYSTEM FOR ELECTRICITY ACCOUNTING IN TRACTION NETWORKS	The invention relates to the field of electrified railway transport and is aimed at improving the electricity metering system in traction networks.	Increase in the accuracy of metering electricity consumption of traction networks.	State Educational Institution of Higher Professional Education Omsk State Transport University (RU)
2505861 2014	G07C5/08	DEVICE FOR CONTROL AND REGISTRATION OF FUEL CONSUMPTION ON A VEHICLE	The invention relates to measurements, in particular, to automated systems for control and recording of fuel consumption by traction vehicles and track machines of railway transport, as well as other vehicles with a diesel engine.	The technical result of the invention is the creation of a device for control and recording of fuel consumption with a minimum measurement error, equipping it with protection from unauthorized access to ensure data reliability and fuel overexpenditure, and equipment safety; acceleration and simplification of data processing by storing them in the database format in the device itself, with the possibility of subsequent transmission of data selected according to a specified criterion to a stationary computer (server), in particular, in the event of accidents or emergency situations.	Joint-Stock Company Research and Design and Technological Institute of Rolling Stock (JSC VNIKTI) (RU)
2513338 2014	B61K9/08 E01B35/12	METHOD FOR ASSESSING THE STATE OF THE RAILWAY TRACK	The invention relates to railway transport.	The technical result is to increase the reliability and efficiency of estimation of the rail track state by taking into account the synchronous action of the longitudinal forces in the train and the forces of interaction of the individual wheel and the railway track.	Joint Stock Company Russian Railways (RU)

Table 2

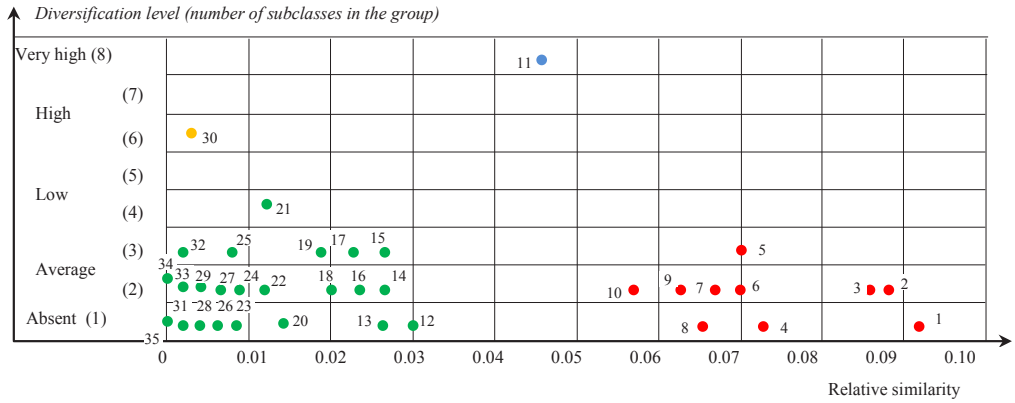
Positioning of patent holders of GLONASS/GPS systems in the field of railway transport

Patent holder is directly connected with the railway transport (PRT)	Cluster (group), in which the patent holder is located on the positioning map (IPC subclasses, in which PRT inventions are patented)	Competing organizations that possess GPS / GNNS / GLONASS technologies similar to those of PRT	Cluster (group), in which the competing organization is located; (subclasses of IPC)
JSC Russian Railways (RU)	O (30) (B61K, B61L, E01B, E04G, G01M, H04M)	Joint-stock company Russian Corporation for Rocket and Space Instrument Engineering and Information Systems (JSC Russian Space Systems) (RU) Federal State Public Institution 27th Central Research Institute of the Ministry of Defense of the Russian Federation (RU)	F (11) (B61L, G01C, G01M, G01S, G06F, G06G, G08G, H04B) L (27) (H04M, H04W)
State Educational Institution of Higher Professional Education Omsk State Transport University (RU)	L (33) (B60M, B63C)	State Educational Institution of Higher Professional Education Far Eastern State Transport University (FESTU) (RU)	K(31) (B60M)
State Educational Institution of Higher Professional Education Far Eastern State Transport University (FESTU) (RU)	K (31) (B60M)	State Educational Institution of Higher Professional Education Omsk State Transport University (RU)	L (33) (B60M, B63C)
Joint Stock Company Tver Wagon Works (JSC TVZ) (RU)	P (35) (B61D)		
Joint-Stock Company Research and Design and Technological Institute of Rolling Stock (JSC VNIKTI) (RU)	K (26) (G07C)	Joint-Stock Company Avangard (RU) Federal State Unitary Enterprise Taganrog Research Institute of Communications (FSUE TNIIS) (RU) International Academy of Ecology, Human and Nature Safety (RU)	F (11) (B60R, G01C, G01S, G01V, G07C, G08B, G08G) K (26) (G07C) K(26) (G07C)

/ or market). Moreover, it should be noted that the directions that are relevant for the industry may have a low level of competition at the stage of formation (as a rule, during a short period).

It is of interest to compare the categories of patent holders by patent classes, which are common for them. For example, out of 63 subclasses, only 14 (22 %) are common for patent owners-organization and patent owners-individuals, which implies that individuals develop technological solutions that will rather not compete but complement technological solutions of strong market players in the form of organizations. A mutually beneficial «supplement» can be implemented through the patent licensing procedure.

Comparison of Russian patent owner organizations with foreign ones gives about 20 % of the total subclasses, which indicates a rather wide variety of Russian GLONASS applications, where there are no foreign patents on our territory yet. Large shares of foreign rights holders take place in subclasses G01C, G01S, H04B, H01Q, H04W, which cover the most significant features of satellite navigation – satellite positioning systems, navigation devices, signal transmission technologies, antennas, wireless communications.



Pic. 2. Map of the positioning of groups of enterprises by the level of diversification and relative similarity.

Stage 2. *For each organization, the nomenclature and the number of subclasses of the IPC are determined, for which it has patent publications in the territory of Russia. In this case, the total number of identified non-recurring subclasses is 63. The set of all non-recurring subclasses forms a set of attributes that are used to determine measures of similarity between organizations. The number of subclasses of IPC in patents of one organization characterizes the level of diversification of its scientific, technological and patent activities.*

Stage 3. *The pair-wise comparison of organizations is carried out and a measure of similarity is calculated for each pair, for example, according to the Chekanovsky–Sorensen formula* $C(S_i,S_j)=\frac{2m(S_i\cap S_j)}{m(S_i)+m(S_j)}$ *[3], where* S_i, S_j *are the sets of subclasses of the IPC in the patents of organizations i and j respectively,* $m(S_i)$ *– cardinality of the set* S_i.

Stage 4. *The obtained values of similarity measures are recorded in the matrix of similarities of organizations.*

Stage 5. *The right main eigenvector of the similarity matrix is calculated, the values of which represent the levels of relative similarity of organizations.*

The positioning of patent holders was based on indicators of the relative similarity of names and the number of areas in which patent holder organizations (individuals were not considered) patented inventions on the territory of Russia.

The field of patenting was defined as a subclass of the IPC. The category «subclass» is the most informative for conducting such an analysis. Analyzing subclasses, it is possible, on the one hand, to fully reflect the breadth of the organization's activity in terms of the diversity of application areas, and on the other hand, to obtain a fairly detailed idea of functional and constructive features of patented technical solutions. Descriptions of subclasses reflect the principal distinctive features characterizing the fields of application and the functional and structural features of inventions. In the descriptions of classes of IPC, insufficient and in the descriptions of groups and subgroups an excessive level of specification of inventions is used to obtain an informative map of positioning of patent owner organizations.

The characteristics of patent owners – organizations in the number of areas (in particular, subclasses) in which they patent invention, makes it possible to assess the level of diversification of their patent activities. The level of diversification shows to a certain extent the level of the scientific and technological potential of the organization. If an organization patents its inventions in a large number of areas, it can be assumed that it has a fairly wide range of strategic technologies and its level of competitiveness in the market will be high in the long term.

The relative level of similarity shows how similar (close) is some object from the considered set to all its other objects according to a certain set of characteristics. In this case, the relative similarity of patent owner organizations was determined by a set of subclasses of IPC. Organizations with a high level of relative similarity have patents in subclasses that are present in a significant number of other organizations. The more organizations patent inventions in one subclass, the higher is the level of potential competition between them. Consequently, the indicator of relative similarity of patent owner organizations to the IPC subclasses allows to judge the level of existing or future competition in its sector. An organization with a high relative similarity index operates in an environment with a high level of competition and, conversely, an enterprise with unique technologies has a low relative similarity and operates in an environment with a low level of competition.

Stage 6. *Individual organizations are grouped into clusters and groups. The organizations included in the group have the same or very close values of relative similarity index and the same number of characteristics – subclasses of IPC. Clusters are formed from groups of enterprises that have the same number of characteristics – subclasses. 15 such clusters were formed.*

Stage 7. *A map of positioning is being created, on which groups of enterprises are designated. The positioning map clearly shows in which area in terms of the level of diversification of patent activity and the level of competition (determined by relative similarity) are groups and clusters of organizations.*

The positioning map of the patent owner organizations by indicators of the relative similarity of names and the number of subclasses of IPC is shown in Pic. 2. The values of relative similarity are plotted along the abscissa axis, and the number of subclasses and diversification levels are plotted along the ordinate axis. All 98 organizations in the analysis are grouped into 35 groups and 15 clusters in terms of relative similarity.

Stage 8. *The selected groups and clusters of organizations are described. Descriptions of formed*

clusters characterize the environment (patent) in which the enterprise is located. One or more groups may be present in one cluster. The groups in Pic. 2 are indicated by Arabic numerals, but can be described by the characteristics of the cluster to which they belong, with the addition of the semantics of the IPC subclasses included in the group. It should be noted that each of the IPC subclasses has the right to enter more than one group.

Types of patent owner organizations

On the positioning map (see Pic. 2), it is possible to distinguish four types of patent owner organizations that differ in the level of diversification of technologies using GLONASS/GPS satellite navigation systems and the level of competition between them:

1 – organizations that own a large number of fundamentally different technologies and have a small number of competitors-patent holders of this type of technology; such organizations operate in the low-risk zone from the point of view of their displacement from the market or absorption by other organizations operating in the field of satellite navigation GLONASS/GPS.

2 – organizations that own a large number of fundamentally different technologies, but have a large number of competing patent holders with similar technologies and therefore operate in a rather risky market segment.

3 – organizations that own a small assortment of fundamentally different technologies and have a small number of competitors with similar technologies, and therefore operate in the same risky segment as organizations of the second type, because in the long term they may lose in technological development to the more knowledge-intensive and innovative diversified organizations of the first and the second type.

4 – organizations located in an extremely risky segment of market and innovation activity, possessing a small diversification of technological activities and having a large number of competitive organizations with similar technologies.

Among the considered patent owner organizations using GLONASS/GPS satellite navigation systems, there are those, that are directly connected with railway transport. Table 2 shows the organizations and technologies (of corresponding IPC subclasses) that they own, organizations-competitors that have similar technologies, and groups and clusters that include all these organizations in accordance with the positioning map (see Pic. 2).

All organizations, patent owners in the field of GLONASS/GPS rail profile belong to the third type of organizations, that is, they own a small assortment of fundamentally different technologies and have a small number of competitors.

The most innovative technological competition in the field of GLONASS/GPS systems can be made by Russian patent holders possessing a higher level of technological diversification: Russian Open Society of Rocket and Space Instrument Engineering and Information Systems (JSC Russian Space Systems) (RU); 27th Central Scientific Research Institute of the Ministry of Defense of the Russian Federation (RU); JSC Avangard (RU); Taganrog Research Institute of Communications (FSUE TNIIS) (RU); International Academy of Ecology, Human and Nature Safety (RU).

On the other hand, when organizations that are directly connected with rail transport carry out an innovation strategy oriented at cooperation, competitors can become their strategic partners, having a synergistic effect from jointly created technologies and strengthening competitive positions in the territory of the Russian Federation, which will allow more effectively to prevent the penetration of foreign patent owners on the domestic market.

Conclusions.

1. With the use of the patent resource Qustel-Orbit and the system of the Federal Institute of Industrial Property (FIPS), 236 patents in the field of GLONASS/GPS, operating in the territory of the Russian Federation, have been identified. On the basis of this information, a systematization of patent holders was developed for classes, subclasses, groups and subgroups of the IPC, which allows to identify potential competitors who patent technologies in the same classes.

2. A technique for positioning of patent holders on the similarity indicators and the number of fundamentally different inventions relating to different subclasses of the IPC has been developed. In accordance with the methodology, the positioning of patent holders in the field of GLONASS/GPS in the territory of the Russian Federation was carried out.

3. The organizations-patent owners directly connected with railway transport have been revealed. It has been established that they own a small assortment of radically different GLONASS/GPS technologies on the territory of the Russian Federation. The main technological competitors for them are Russian organizations, which rather act as potential strategic partners in the development of innovative technologies based on GLONASS/GPS for rail transport.

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