

# Characteristic Barriers to the Implementation of the Roadmap for Augmented Reality Technology Development Program

Vadim Zhmud  
*Dept. of Automation,*  
*Novosibirsk State Technical University*  
 Novosibirsk, Russia  
[oao\\_nips@bk.ru](mailto:oao_nips@bk.ru)  
 ORCID ID 0000-0002-1708-9211  
 IEEE member, ID: 95001934

Aleksandr Liapidevskiy  
*General Director of Novosibirsk*  
*Institute of Program Systems,*  
 Novosibirsk, Russia  
[nips@nips.ru](mailto:nips@nips.ru)  
<http://nips.ru/komanda>

Valery Avrmachuk  
*School of Information Technology and*  
*Robotics. Department of Automation*  
*and Robotics*  
 Tomsk Polytechnic University  
 Tomsk, Russia  
[avs@tpu.ru](mailto:avs@tpu.ru)

**Abstract**—The paper discusses the characteristic barriers for the development of a detailed map of the Program for the Development of Virtual and Augmented Reality (VR/AR) Technologies. The team of authors took part in the development of an alternative version of such a roadmap, since the main executor was another consortium of experts. An alternative point of view is always useful, in particular also because so far, the specified roadmap has not gone beyond the stage of discussion, it is theoretically possible to make amendments and additions to it. At the same time, even in case of its approval, a five-year term has been released for its implementation. During this period of time, possible adjustments to plans, opening of unrecorded technological barriers with which to fight. Therefore, this paper may be useful for those who are planning the development of these technologies, and for those who will work on these plans. The article contains the results of an in-depth analysis of the situation and forecasts on this basis, made during the expert consultation process of the main developers of the roadmap (some of the authors were among the authors of the final roadmap to be submitted for approval by the Government of the Russian Federation).

**Keywords**—VR/AR, augmented reality, end-to-end technologies, virtual reality, roadmap

## I. INTRODUCTION

The development of cross-cutting technologies requires the active participation of government funding, as well as co-financing from major industrial partners. Financing is possible only in case of full transparency of the plans. Indeed, the advance payment of research aimed at the development and introduction of new technologies is possible only if the financing partner receives full information on how these investments can be converted into profits over time. Moreover, common phrases can convince only those “experts” who do not protect the interests of the investor as their own. Unfortunately, such experts are found everywhere. With such unscrupulous experts in China, they are acting quite undemocratic, but perhaps this is one of the secrets of the economic miracle, which is called the last half century of development of China’s industry.

The task of developing a roadmap is extremely important because at present the roadmap is understood as the most

developed development plan, containing many important sections, among which there is a list of critical sub-technologies, and a list of key organizations that can claim to be regional leading research centers, the list of main implementing organizations, a list of possible technological and other barriers and ways to overcome them. Also, the roadmap should contain an analysis of the technological readiness of each selected sub-technology, a matrix of projects, the implementation of which will form the necessary sub-technologies, for each project should be indicated numerical indicators of goal achievement, that is, such indicators that cannot be taken in terms of “improved”, “increased”, “increased efficiency”, they should be expressed in numerical terms - percentages, rubles, the multiplicity of increase in revenues or their values by year, and so on. Of course, in the time frame for which roadmaps are being developed, it is impossible even to completely and completely finalize the project matrix, so there is no need to speak about numerical indicators of goal achievement for each individual project. It turns out to be a somewhat strange, but typical picture for today’s realities: the smallest sums spent on financing projects require a detailed development of the entire project in the complex, the products offered for development must be substantiated in detail, the costs and profits should be scheduled by year throughout the life cycle of this products, starting with the draft, ending with the curtailment of production (when it ceases to pay for itself), taking into account the cost of disposal of all components of this production.

For projects requiring the largest investments, such details are not required. This can be explained by the complexity (and, probably, impossibility) of taking into account all the details of ambitious projects, but at least each team working on a project at its own level, apparently, should develop it in no less detail at its own level. It means that if a project is worth 200 thousand rubles. for two years requires filling from ten to fifteen different forms, it is logical that a project worth 20 million rubles. should require no fewer forms, whereas in practice it may be sufficient to fill from six to eight forms. For a project of 90 million rubles. up to 900 million rubles. It may be sufficient to fill out four or five forms, several standard references about the enterprise and one presentation, and for the approval of a generalizing roadmap for which it is supposed to spend 50-80 billion rubles. It may be sufficient to fill out two or three standard forms and one presentation. And it does not matter at all that one or two of the indicated forms may contain information of considerable volume, since in this

case one table of contents can take up to 50 pages, but the content of most sections is completely standard, often repeated in various roadmaps simply because some of the points it is impossible to fill in creatively, they are not so essential as to seriously influence something. The list of critical sub-technologies is just one sheet, and it is possible that only a few lines, since it is recommended to indicate at least five, but not more than twenty sub-technologies. The matrix of projects is also, probably, a single sheet. Indeed, if sub-technologies are arranged in lines, there will be no more than twenty lines, the sequence of projects cannot be too long, since the Program is designed for five years, and a project of less than a year is not real.

Thus, even if there is an approved roadmap, some questions remain that are relevant to raise and explore, and take note of the results of such a study.

## II. STATEMENT OF THE PROBLEM

The paper sets the task of exploring possible technological and other barriers to the implementation of a roadmap for the development of end-to-end technologies in virtual and augmented reality. The basis for the study is the Atlas of the road map developed by the State Atomic Energy Corporation "Rosatom" [1, 2], as well as personal experience of discussions with experts, the results of information search in various sources and the authors' own research experience.

The aim of the study is to find possible unrecorded barriers and possible weak points in the developed roadmap.

## III. THE MOST CHARACTERISTIC ERROR

The most typical erroneous formulation of the problem is the authors' inadequate attention to the component related to augmented reality, bordering on neglecting it. At the same time, the authors of the roadmap forget that technologies are called "Virtual and Augmented Reality" technologies, and initially in the Atlas [1, 2] they were called "Augmented Reality" technologies without any mention of virtual reality [3–9].

Thus, due to two seemingly permissible actions, the original meaning has been completely lost. Indeed, the combination of virtual and augmented reality can be justified by the fact that augmented reality technologies should largely rely on virtual reality technologies, therefore the development of virtual reality technologies will benefit from augmented reality technologies. Combining in one project, in a single roadmap can make the sense that it avoids duplication. The next step, if it is considered in isolation, can also be explained by some conditionally justified considerations. For example, it can be said that with virtual reality technology everything is the most understandable (you can also add that they are most effective, they allow you to simply shock the actors using devices that carry the subject from reality to virtual reality). However, in general, this approach is flawed.

Initially, new technologies were needed that are not available and that are extremely complex. As a result, already widely used technologies are being offered, which are not particularly worth financing, since they have already reached the stage of self-sufficiency.

Therefore, if a roadmap should formally combine virtual and augmented reality, but all projects and all future prospective applications are associated only with virtual

reality, the problems of augmented reality are out of sight, then such a roadmap is difficult to approve.

Even if virtual reality technologies are developed in sufficient detail, and the issue of combining virtual reality with real, creating augmented and combined reality is not affected, then the problem is not that someone likes or dislikes this document. The problem is that if technologies are developed according to such a roadmap, as a result, no technologies of augmented reality will appear in five years.

## 3. Erroneously narrow orientation of the roadmap.

Another characteristic mistake is that even within the consideration of only virtual reality, all possible applications and future effects are associated only with training, with a more spectacular spatial display of museum or projected objects. Such important applications as gaming applications, entertainment, film industry fall out of focus. The fact is that these applications are the main source of funds for the development of these technologies. If, when planning the development of technologies, the most significant sources of financing are not taken into account, the mechanisms for recouping of sub-technologies are not visible, which constitute a higher level of technologies, then the assessment of the required funds for the development of this program will be erroneous several times, not a few percent.

## IV. ERRONEOUS ACCENTS ON LOW-PROFILE BARRIERS.

Roadmap developers often point out completely insignificant barriers, and the real obstacles to the development of roadmaps are not economic and not social, but technological. Social obstacles in comparison with them are insignificant. An analysis of these barriers will be given below [3–9].

## V. NON-ESSENTIAL CRITERIA FOR ACHIEVING GOALS.

Another characteristic mistake is to put forward unimportant criteria for achieving the goal. For example, the authors of a roadmap see it as an important criterion to achieve a situation where the subject almost does not distinguish virtual reality from reality. That is, the higher the presence effect, the fewer factors that remind users that virtual reality is in reality only deception created by computational technologies and technologies of deception of human perception, the better, in their opinion, the task is solved.

This indicator, apparently, is very important precisely for the direction that has been missed from consideration, associated with the entertainment industry. When the post appeared, it seemed surprising to people that they could write a message anywhere in the world, and it would be delivered there for a small fee. With the advent of telephone and radio, people were able to talk with interlocutors anywhere in the world and even beyond. Television technologies allowed not only to talk, but also to see each other, and digital technologies and color monitors made this pleasure accessible to almost everyone, while the image quality is extremely high. Subsequently, people learned how to create three-dimensional images, several microphones and several speakers were also used, which made it possible to create a surround sound effect.

In entertaining shows, winds, splashes of water are formed, smells are simulated, vibration is formed, effects on the vestibular apparatus and tactile sensations of the skin can

be made. In combination, this allows you to create an almost complete illusion of being present in any place, even if such a place does not exist at all. However, all these are only virtual reality technologies that are very important for the entertainment industry, but not so important for augmented reality technologies.

The main thing in technologies of augmented reality is not to introduce the subject into a deceptive state, not to lead him out of reality into a certain illusory world, but to fill his perception in such a way that would allow him to more effectively solve the set task, while it is highly desirable that the subject remains sober, not mad with excessive abundance of sensations. Therefore, not only is deception not extremely desirable, it seems to be highly undesirable in the case of augmented reality. We should not strive to ensure that virtual reality objects do not differ in perception from reality objects. On the contrary, one should strive to ensure that the subject using these technologies always clearly separates which of the components of his expanded perception are virtual and which belong to reality.

#### VI. INABILITY TO DISTINGUISH VIRTUAL REALITY TOOLS FROM AUGMENTED REALITY TOOLS

The issues of displaying graphic information on displays and on glasses, on screens and on gadgets, indeed, have long been successfully resolved (although they will be developed). But the technology of augmented reality assumes something different - as a rule, it is supposed to remove optical information not on the screens, but to create images on surfaces and environments that are not specially prepared for this purpose screens. This is the most important sub-technology; we should not forget about it.

Of course, there is another possibility: to use translucent glasses, glasses of helmets, visors, monoculares, as well as the use of external devices not fixed on the head, such as navigation gadgets, rear-view mirrors, monitors of external cameras. But if we bear in mind these technologies, we should also recognize that they are already well developed, they are already paying off, manufacturers of such devices can direct their profits to the development of these technologies, if only because that is what any successful manufacturers of innovative products do. If profits are not invested in technology development, profits will soon end and losses will begin, as competitors will conquer the market due to more rapid use of emerging opportunities due to the development of external technologies and the success of their own developments. Therefore, government funding of gaming applications is not required, government participation in the development of virtual reality technology is possible, but not necessary.

We are guided by the following principle with this statement: there are such directions of development of technologies that are able to draw funds for self-development from their own profits, there are also those that require excessively large start-up costs, therefore they cannot start self-development without large investments. At the same time, the whole of science as a whole is developing in one way or another with the development of civilization, and after it develops both technology and industry. Even if nothing is done, there will still be progress, but it will not be as we would like, not there, not with us, not with the effect it needs. Therefore, the state is obliged to finance the development of science and technology. But since there is always not enough

money, you have to concentrate on something, since it is impossible to concentrate on everything, you have to choose.

In this situation, it is possible to finance what is already developing and paying off, but this approach is not a state one. Private investors do it - they invest in the place where you can get the most profit. About this Karl Marx wrote, it is a mechanism for the flow of funds, market regulation. If the state plays the role of a market, it will turn into a market, that is, it will cease to exist as a state. To finance a successfully developing industry with additional mega-grants is the same as purchasing medicines only for healthy people, transporting birds in a balloon, or purifying distilled distilled water. Mega-grants should finance the development of such technologies that have at least two signs: a) the state is extremely interested in the early development of these technologies to produce the necessary products or to obtain the necessary economic or other benefits (or preserve them); b) without the specified financing the required pace of development is impossible.

Decisions should be made not at the level of argumentation "why not finance", but at the level of argumentation "it is impossible not to finance". Of course, if everything that cannot be financed is funded, and additional funds remain, then other tasks can be discussed, but this time, apparently, has not yet come, and is unlikely to come in the coming years.

#### VII. ANALYSIS OF DECLARED BARRIERS

In the preliminary conclusions of the expert group, barriers are allegedly limiting the introduction of AR / VR technologies common to most developed countries of the world. The question immediately arises: why are barriers in all countries very different from barriers for Russia? Again, let's talk about some special way? Maybe it is just necessary to slightly stop the growth rate of privatization of state resources, or even start organizing the decline in this indicator, and not only in words? The following barriers are indicated.

1. Inadequate convenience and ease of use, high cost of devices, insufficient image and content quality, limited interaction, the need for habituation.
2. Barrier digital detoxification.
3. Image quality.
4. Difficulties in creating content for VR / AR, high cost of AR / VR gadgets, attachment to productive systems (with large-scale application of technology).
5. The economic feasibility of VT.
6. Long payback period, high start-up costs, errors in assessing technical capabilities and barriers.
7. The imperfection of technology, the lack of relevant specialists.
8. The high cost of AR / VR systems for the end user, the lack of articulated advantages of AR / VR solutions in comparison with traditional solutions (screens, projections, etc.)
9. There are no studies on the mental impact of AR / VR technologies.
10. Fear of new technologies, low penetration rate of devices.
11. Cost of equipment.

12. Markets in its infancy.

13. The lack of specific consumer benefits that make AR / VR indispensable, the cumbersome equipment.

14. The low level of quality of technological devices, coupled with high cost" [3–9].

Note that paragraph 3 is a repetition of part of paragraph 1. The high cost in paragraph 1 is duplicated in paragraph 4, and then again separately recorded in paragraph 11, also repeated as "high starting costs" in paragraph 6. Paragraph 5 surprises by its wording. If the works are not expedient, they should not be done, if they are expedient, then this item is not a barrier. Perhaps the authors had in mind the "lack of certainty about the presence or absence of economic expediency". Then it should be written.

Strange point 7. If technologies were perfect, then why develop them? A masterpiece is paragraph 13 - the lack of specific consumer benefits. Either people wrote who did not represent the essence of what they were writing about, or they wrote that they were not quite in adequate condition, "tired of cognac". Point 10 is also absurd. Apparently, the fear of new technologies makes Disneyland visitors sign up for a month to visit new attractions and wait two hours in order to visit the attraction, which lasts from 10 to 20 minutes. In general, the second and the most important technological barrier in this list is the second half of clause 6, namely: "errors in the assessment of technical capabilities and barriers", which the authors of this list made.

#### VIII. ANALYSIS OF PLANS

Rid our readers of reading long quotes. In general, two types of results are planned: a) to develop what has long been in the world; b) improve the quality of what is available (but not in Russia).

At the same time, the authors have forgotten that Russia is the supplier of programmers for the whole world, since training of programmers is a complicated procedure that requires high competence, high costs and a long time, and there are practically no places left in Europe and the USA where programming could be done for free. Most universities take from 1,000 to 1,500 euros per year, the term of receiving education is everywhere about the same period - 4 years for bachelor and 1.5 to 2 years for masters. Only in France and in very few countries can a higher technical education be obtained free of charge. But employers in Russia in terms of the package of proposals are far behind employers all over the world. Therefore, brilliantly trained programmers have a choice: either to be satisfied with a meager salary by world standards and to work honestly for a single employer (if they have not yet become extinct), or in such a situation, still work on an outside employer (often without leaving the formal workplace, which based on the presence of a programmer's body there and the use of a computer and an Internet network in the same place), or simply leave the borders of Russia and move to the country where your knowledge, skills, is old Nia and the results are appreciated. In this situation, it is difficult to expect the prevailing development of software on the territory of Russia, therefore, first of all, investments in the Digital Economy Program of Russia should contain measures not only for securing domestic key personnel, but also measures for their repatriation, that is, for our programmers to return home offering them better working conditions and social packages (not only their salary, but also hers). All

developing countries (that is, those that are parting with their backwardness) have programs for the repatriation of IT personnel, and perhaps such programs are also a partial explanation for China's economic miracle.

Nevertheless, we quote some of the proposals in the field of software.

"Develop an editor for the virtual presentation of appearance that allows you to reproduce the appearance of a person in a short period of time (up to 60 minutes) as opposed to purely game avatars." That is, if a digital avatar is formed in less than 60 minutes, the desired will happen - the Russian economy will take the lead in the VR / AR area, that is, this is not a sufficient condition, but apparently obviously necessary. The construction of a digital image in 60 minutes, achieved in 5 years of development with priority financing, seems to be a too dull prospect. Let us omit some further opus on this topic and consider a set of economic barriers that are directly in the way of the implementation of these technologies in Russia.

#### IX. ANALYSIS OF ECONOMIC BARRIERS TO THE INTRODUCTION OF AR / VR TECHNOLOGIES IN RUSSIA

The following list is given (we entered numbering):

1. Low purchasing power of citizens, lack of own production of electronic devices, insufficient government support for the introduction of innovative technologies in private companies.

2. Low level of financing of any type.

3. Now technology is perceived to a large extent as a toy. Customers are willing to spend money on it only in the context of the Wow effect, but are not ready to create business tools on its basis. Accordingly, if there are no products with serious revenue, then there is no significant investment.

4. High cost of production solutions (not single projects), insufficient market of specialists and integrators of VR / AR technologies with a high level of competence in this area

5. Availability of VR equipment.

6. Financing should reach existing specialists in economically justified amounts, targeted, complete, responsible, empty publications and localism should not affect funding, contract terms and target indicators should exclude substandard or incomplete works, articles, monographs, textbooks and age, include technology adoption and level of implementation.

7. Development price

8. Lack of available funding for initiative development, lack of concessional conditions for developers

9. Do not see exhaust industrial giants

10. Production of content for virtual reality requires a solid budget.

11. The high cost of decisions.

12. Lack of interest in most venture capital funds.

13. The difficulty of obtaining investment, the lack of benefits for the industry, including tax, the difficulty of obtaining grants.

14. The high cost of user equipment" [3–9].

The first item collects everything, and there is a low level of state support. This is strange: do experts write about barriers that can impede the effective use of state support, and say that this can be hindered by its low level?

Imagine that we take a loan from a bank, and we are asked: "Can we be sure that you will spend this money correctly? What can prevent you from spending them correctly?" And we answer: "It may be prevented by the fact that the amounts provided will be insufficient". Is this normal? Point 2 - rehash the same. Item 3 - a literary opus on a given topic. Point 4 is again a repeat of the high cost. Point 5 is ambiguous - is the presence or absence of equipment a barrier? And isn't it the goal of the program - its development and creation? If it is already there, it can be bought, at least partially, if it is not there, it should be done. This is not a barrier, this is the initial state, you just need to know it, take into account and develop a program of further actions, which is called a roadmap. Paragraph 6 was included in the list in our opinion; this is our wording; however, this was suggested not as a barrier, but as one of the clauses of the conditions for providing funds. This is clearly not a barrier. Paragraph 7 is again a repeat of high prices, paragraph 11 is the same, paragraph 14 is the same. The high cost of the program is not a barrier, but a necessary condition for the state to agree to finance this program. Paragraphs 12 and 13 are again the same, only on the other hand, because if there were no high cost, there would be no problem with financing, or if there were no problems with financing, then there would be no value for high cost. So, we see the extreme lack of professionalism of this document.

#### X. REAL BARRIERS TO THE IMPLEMENTATION OF AR / VR TECHNOLOGIES IN RUSSIA

In our opinion, the main barriers to the implementation of this program in Russia are:

1. It is likely that plans will be developed unprofessionally. The absence of a mechanism for the actual involvement of competent and independent experts in the development of roadmaps.

2. It is likely that the program of AR / VR technologies will degenerate into a program of VR technologies only.

3. It is likely that the list of critical sub-technologies will only include developments or projects (not in terms of sub-technologies, but in terms of products or worse, projects or project executors), focused on local interests presented by experts.

4. The probability that the insufficient quality of the roadmap will cause the transfer to further development of other expert teams, more independent and more professional, is low.

5. The probability that sufficient funding will be released and aimed at the real development of the really necessary technologies, is small in Russia, is small. On the contrary, it is likely that the bulk of funding will be utilized among those who make the most responsible decisions at the highest level, as well as among those who prepare reports on the implementation of programs. Most of the funding, apparently, will not leave the limits of the two capitals, and the one that leaves will be sent directly to the purchase of technical software and hardware for the final show with the aim of a formal report on the results, which will be less than planned.

6. There is a high probability of further personnel leakage abroad and the transfer to it of the know-how associated with the developed technologies.

7. Without proper control, it can turn out that the development of BP will occur at the expense of budget funds, and profits will sink into the pockets of extrabudgetary organizations and companies, private owners and investors, and so on.

#### XI. PROPOSALS FOR MEASURES TO OVERCOME THESE BARRIERS.

First of all, let us turn to clause 6 of section 9. This should be the first item of measures to overcome barriers.

To this end, decisions on the allocation of funding should be made on the basis of a scientifically based technology development program (that is, on the basis of the roadmap, which is really composed by a team of independent and competent experts, these two qualities are still lacking, especially at the same time). The roadmap should contain numerical indicators of the achievement of goals, which in reality correspond to the development goals of the technologies discussed.

At the moment the situation seems to be this.

1. There are very few serious examples of the use of augmented reality. Therefore, the program of their development is almost empty. Therefore, either this funding is premature, or, for a start, the task of researching real (and not fantastic) applications of augmented reality should be seriously posed. Currently, this concept includes infrared and ultraviolet vision devices, devices with visualization of pictures from a large number of user-friendly cameras, devices with visualization of pictures obtained from ultrasonic sensors, radars, lidars, sonars and some other devices. medical devices (ultrasound scanners, tomography, x-ray devices), etc. These directions can be developed individually or as part of a single program, for their development there is no need to combine them with the fashionable term of augmented reality, but only they represent at least some semblance of what is required to be obtained.

2. Devices for the formation of virtual reality have already reached the stage of recoupment, their development in Russia along some separate path does not seem to be necessary, which does not exclude their state support. However, if such support will be made from the means of the program, called the program of virtual and augmented reality, it should be understood that the augmented reality will remain deprived, all funds will go to the development of virtual reality.

3. The expenditure of funds and the obtaining of intermediate results in accordance with the roadmap should be carefully monitored, especially in light of the barrier at number 7.

#### CONCLUSION

An alternative view is given on how it is most efficient and useful for the state to implement the development of a cluster of virtual and augmented reality. Emphasis is placed on distinguishing these two components, whereas most often these components merge together unreasonably, after which the "augmented reality" direction remains out of attention, which can lead to undesirable distortions in financing.

The main problem is the lack of competent and independent experts among those teams that are trusted by the sponsoring organizations.

REFERENCES

- [1] URL: <http://digitalrosatom.ru/proektnyj-ofis-cifrovaya-ekonomika-rf-gk-rosatom-podgotovil-pilotnuyu-versiyu-doklada-atlas-skvoznyx-technologij-cifrovoj-ekonomiki-rossii/> Date: 06.05.2019.
- [2] URL: <http://digitalrosatom.ru/wp-content/uploads/2019/01/%D0%90%D1%82%D0%BB%D0%B0%D1%81-%D1%81%D0%BA%D0%B2%D0%BE%D0%B7%D0%BD%D1%8B%D0%B5-%D1%82%D0%B5%D1%85%D0%BD%D0%BE%D0%BB%D0%BE%D0%B3%D0%B8%D0%B8-%D1%86%D0%B8%D1%84%D1%80%D0%BE%D0%B2%D0%BE%D0%B9-%D1%8D%D0%BA%D0%BE%D0%BD%D0%BE%D0%BC%D0%B8%D0%BA%D0%B8-%D0%A0%D0%BE%D1%81%D1%81%D0%B8%D0%B8.pdf> Date: 06.05.2019.
- [3] URL: <https://tass.ru/nacionalnye-proekty/6298845> Date: 06.05.2019.
- [4] URL: [https://data-economy.ru/14032018\\_01](https://data-economy.ru/14032018_01) Date: 06.05.2019.
- [5] URL: <https://news.rambler.ru/other/41986682-dvfu-sozdast-dorozhnyu-kartu-razvitiya-vr-tehnologii-ovmestno-s-drugimi-vuzami-i-biznesom/> Date: 06.05.2019.
- [6] URL: <https://media.kpfu.ru/news/sotrudniki-vysshey-shkoly-itis-prinyali-uchastie-v-podgotovke-dorozhnoy-karty-cifrovoy> Date: 06.05.2019.
- [7] URL: <https://rg.ru/2018/04/17/v-dvfu-zajmutsia-razrabotkami-v-oblasti-virtualnoj-realnosti.html> Date: 06.05.2019.
- [8] URL: [https://ntinews.ru/in\\_progress/skvot/virtualnaya-i-dopolnennaya-realnost-na-dalnem-vostoke-realnyy-neyronet.html](https://ntinews.ru/in_progress/skvot/virtualnaya-i-dopolnennaya-realnost-na-dalnem-vostoke-realnyy-neyronet.html) Date: 06.05.2019.
- [9] URL: <https://ar-conf.ru/ru/news/nti-sostavlyayet-dorognuyu-kartu-dlya-razvitiya-ar-i-vr-v-rossii-61547> Date: 06.05.2019.