Critical technologies in the cluster of virtual and augmented reality

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Abstract. The program "Digital Economy of the Russian Federation", launched in 2019, contains virtual and augmented reality technologies in its list. Each such technology consists of many assistive technologies called sub-technologies. These assistive technologies make up a large list, while failure to obtain the required results in at least one of these technologies may lead to the fact that the integral technology will not be created. This article discusses a list of only critical assistive technologies, that is, precisely those technologies whose creation is a critical factor for creating a generalized (integral) technology. It is on these technologies that the main emphasis should be placed not only in financing their development, but also in the thorough planning of goals and objectives, in the selection of performers and in the acceptance of research results.

1. Introduction
The implementation of the national research program "Digital Economy of Russia" began in 2019, initially it identified nine areas of technological development [1], of which only six remained later [2]. Initially, the list included the following technologies: virtual and augmented reality technologies, neuro-technologies and artificial intelligence, robotics components and sensor technologies, big data, wireless technologies, distributed ledger systems (blockchain), industrial Internet, new production technologies and quantum technologies [3]. Four roadmaps were adopted in the first reading: 1) artificial intelligence, 2) distributed ledger technologies (blockchain), 3) quantum technologies, 4) virtual and augmented reality technologies. Two more roadways will be improved, these are: 5) new production technologies and 6) wireless communication (5G) [3]. The first year of this program can be considered lost, since the actions to distribute funding were extremely hasty and sometimes unreasonable, perhaps this was the reason for the change of the main responsible government official, therefore it is especially important to correctly develop these technologies in the remaining four years.
2. Statement of the problem

There is no point in explaining the essence of the concept of virtual reality, since nowadays this understanding has been achieved everywhere, and for general education you can refer to the corresponding sites. We will focus on augmented reality and how our understanding differs from the conventional, which is not professional, but has become predominant.

Augmented reality, as you know, is a virtual reality component that is brought into actual reality. The key technologies here are, firstly, the technologies for introducing this additional component into the user's real sensing system, and secondly, the methods of its preliminary transformation so that it is perceived in the most harmonious way.

Effective use of augmented reality does not require the inability to distinguish its elements from reality. This can only matter in the entertainment industry, in some very specific simulators and in some very specific cases. In practice, a person who does not distinguish digital deception from reality can be classified as deceived or mentally ill. If, of course, this deception is so successful that no sense organs can detect it, and a person needs to act in actual reality, and not in virtual and not in augmented reality, it turns out that such augmented reality, instead of expanding his sensory capabilities, takes away him from the real world, that is, hinders his effective activity. Therefore, augmented reality should in most cases clearly differ from physical reality, at least so much that the user does not react to it in an erroneous way. A realistic image of the abyss may add drive to the computer player, but if he, having broken off from it in the game world, dies of a heart attack, since he believes that his life is really in mortal danger, there is nothing good about it. Thus, one of the directions of augmented reality should not replace real images of the external world with virtual fakes, but provide the necessary additional information, explanations, prompts for action.

An example of this would be a navigator hint. Currently, it is a voice, text or graphical prompt, or a combination of these types. Ideally, such a prompter should provide instructions in a form that is most comfortable for the driver, as this is required to improve driving safety. It is useful to visualize the most critical road signs, especially considering the expected actions in connection with its movement along the route. Other clues are also desirable, which are currently not yet available, but which are not prevented from appearing. For example, since GPS and GLONASS systems can see the entire situation on the route, and digital technologies can predict the actions of a driver whose route is known quite well in the next few minutes, such prompts could inform the driver about the danger of his planned maneuver, or vice versa about the safety of the maneuver. In particular, it would be desirable to warn about other vehicles and obstacles that will arise on the way in the very near future. For example, if the driver has planned to overtake, as indicated by his preliminary actions, but he does not see the oncoming vehicle due to poor visibility, or is not aware of the peculiarities of the road surface, the road profile or other obstacles for this maneuver, then a voice message, for example of this type “Attention! Overtaking is dangerous, oncoming traffic is dangerously close!” could in many cases exclude the worst kind of accidents – a head-on collision. In particular, it is also known that very often road accidents occur for the reason that the driver believes that he still has time to slip through the green light, and another driver leaves the intersection too early, predicting that the green light has already turned on for him. In other words, both drivers consider the yellow light to be permissive for themselves, while in fact it prohibits all drivers, except for those who stop driving. Occasionally, drivers do not notice vehicles that take advantage of the siren and flashing lights. In such cases, it would be useful to submit a message, for example, “Danger on the right!” or “Car with a siren on the left!” Also, sometimes the cause of an accident is open hatches, cuts, puddles, objects on the road, sharp objects tearing tires, objects that have fallen from previous vehicles, and so on. To detect them, special sensors in cars could serve, GPS and GLONASS systems do not detect them, but such sensors would be very useful to increase traffic safety. Note that there is no emergency notification even in the event of those obstacles that these systems fully recognize. The reason for this is, firstly, the large delay in their detection, which makes such an alert meaningless, since it would still be late, and secondly, apparently, while nobody stated this task.

Similar technical solutions can be offered for training cases, and for helping physicians during an operation, and for specialists who repair and maintain complex equipment. These technologies are
already relatively efficiently practiced in gaming applications, in various attractions. In a sense, Disneyland was the prototype for augmented reality platform.

3. The main critical sub-technologies
Augmented reality should have the following features: 1) combine virtual and real; 2) interacts in real time; 3) work in 3D [4].

If you use the image of augmented reality objects on a computer screen or any gadget (the first approach), this does not require any new technologies.

If you use virtual reality glasses (second approach) or turn the walls of the room in which the user is located into screens (third approach), this also does not require substantially new imaging technologies, but this requires technologies for preliminary creation of objects of this virtual reality by means of their appropriate distortion. to obtain such projections that would deceive the user's perception, making the generated reality most similar to volumetric, especially when the user moves and turns the head. Thus, this approach requires only computational methods, which, strictly speaking, is not a new technology, but is a branch of applied mathematics. With a large amount of computation, this is associated with an increase in computing power and the development of more efficient programs, probably also with the development of more efficient algorithms, but these are not production technologies.

The fourth approach is to create a hologram. If a hologram is created on a semitransparent medium, these technologies already exist, but their development is undoubtedly required in the direction of higher resolution, better color reproduction, and higher speed. Without a specially prepared screen, these technologies can exist on random and regular media. An example of a regular medium is the blades of a rotating fan, which creates the effect of transparency in an image that seems to hang in the air. An accidental carrier can be fog, aerosol, or other particles that scatter light at certain points, but generally transmit it. These technologies are very complex, their development seems to be very expedient, it will advance technologies in any case, and not only for augmented reality. In this area, science fiction films demonstrate miracles that, unfortunately, are not yet achievable in practice. This refers to the creation directly in the air of volumetric images that are indistinguishable from images of real objects. We assume that such technologies for creating dense color moving images in an ordinary atmosphere without admixtures of fog, splashes, aerosols, without moving or resting scattering objects within the framework of the discussed program will not be reliably created until 2024. This does not mean that research in this direction is useless, but if the program should fund only those research that in the near future (within a calendar year from the beginning of funding) will yield an output with the production of products using this new technology, then such projects are most likely overly optimistic.

The fifth approach is to project the image onto particles in the air. Such particles are almost invisible in the absence of illumination, and under illumination they can glow so brightly that even short-term flashes, for example, with a duty cycle of Q = 10, are perceived by the eye as a constant glow. These are very complex technologies, but they are quite realistic, their development can really be carried out over a period equal to a calendar year. But their application is much narrower than technologies according to the fourth approach.

The sixth approach may be to obtain the same effect as the fifth approach, but with very high laser power. This allows you to create pictures not on special aerosols, but even on natural dust particles present in almost any atmosphere. This method is very dangerous for the eyes of the observer and is characterized by huge energy costs, so it does not seem very promising yet.

The seventh approach is to project images onto objects of reality. For example, an image of a battle panorama is projected onto a number of architectural structures, while such corrections are made to the images that lead to the fact that the structure of real objects is completely masked. This method is based on large calculations and is effective for massive shows in impromptu locations, such as city squares. It is doubtful that it is advisable to develop this method through government funding; it is quite capable of developing through the self-development of enterprises that specialize in mass shows.
4. Possible goals for AR use

Much has been said about using augmented reality to reveal additional information about an object. More than half of these examples are not directly related to augmented reality. The user simply reads some product codes and receives additional information about this object on his gadget. Similar technologies exist for amateur naturalists and professionals. By entering an image into his gadget, the user can get the result of its recognition, the programs recognize animals and plants, report their Latin name, after which the user can find any available information about it by the name of the species. Unfortunately, these programs are not yet reliable enough, it would be rash to use them to distinguish edible mushrooms from poisonous, harmless snakes from poisonous and so on, a program error can cost the user too much.

Technologies combined with smart sensors are the most interesting, but also the most complex. They can offer the user many additional properties, in fact, they expand his sensory capabilities. The user can determine the distance to the object, see the details of its image, can get the capabilities of night vision, thermal imaging, pattern recognition and so on. The prototypes of such devices are binoculars, microscopes, telescopes, range finders and night vision devices. In digital technologies, images are formed not by transforming them by analog means (magnification, amplification), but using digital image recognition and digital formation of new images, and between these two operations any digital image processing can be carried out.

Close to this is the technology of automatic translation of speech from one language to another, but these technologies do not require any new hardware today, they can be developed exclusively by software.

Augmented reality technologies can help people work more efficiently in extreme situations: rescuers, firefighters, cavers, miners, sappers, construction workers, doctors, and so on.

In general, it can be argued that the most critical technologies in this area are, firstly, technologies for collecting a large amount of data on objects of the surrounding reality, secondly, technologies for processing these data, thirdly, imaging technologies and, possibly, others. sensations such as tactile. Sound shaping technologies, although they are adjacent to these technologies, should not be included in this list, since they are already so well developed that their further development in the near future is not critical; special funding for their development is not required.

5. Conclusion

Based on the analysis of the main problems the paper has given the view on the main sub-technologies of VR-AR.

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