REASERCHING THE POSSIBILITIES OF USING INNOVATIVE TECHNOLOGIES IN THE DESIGN OF PROTECTIVE MASKS

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Abstract. *The research has shown that the current development of face mask design using 3D scanners indicates the high potential and prospects of this technology for improving the quality of life, health, safety and comfort of people and society. The basic requirements for the design of protective masks are outlined. It is proved that 3D scanners allow obtaining accurate and detailed images of the human face, which can be used to create individual 3D models of masks.*

Keywords: *design, 3D models of protective masks, 3D scanners, innovative technologies, digitisation of face masks.*

Introduction and problem statement

The outbreak of the coronavirus pandemic has exacerbated the issue of developing protective face masks. Face masks are an important means of protection against viruses, bacteria, pollution and allergens. However, not all masks are equally effective, comfortable and aesthetically pleasing. Designers and engineers are looking for new ways to solve these problems using 3D scanners and 3D printers. However, since masks are a must-have today and in the future, we set out to explore their types, design and manufacturing features. It is also relevant to study the possibility of ensuring their sufficiently effective use, as well as to justify the feasibility of choosing and using passive 3D scanners based on modern smartphones with appropriate software. Modern 3D printers allow for the quick and cost-effective production of protective masks from various materials: plastic, rubber, fabric, biopolymers, composites, etc., as well as different aesthetics, colours, textures, prints, details, accessories, etc.

Methodological part

The research methodology is distinguished by the use of a systematic transdisciplinary approach; it is based on the analysis of scientific, technical and regulatory information, production publications on the subject for systematisation and generalisation, comparative analysis of 3D scanners and software for them, and is also based on visual-analytical and information-research approaches.

Results and discussion

3D scanners provide accurate and detailed images of a person's face, which can be used to create individual 3D mask models. Such masks can be adapted to the shape, size, features and needs of each user. For example, masks can have different levels of protection, breathability, hydration, aroma, thermoregulation, sensory feedback, intelligent functions, and more.

It should be noted that improper wearing of masks can even harm human health. Thus, the main recommendations of the World Health Organisation for effective protection of a person when wearing masks are as follows: the mask should tightly cover the mouth and nose, leaving no gaps;

the mask should be put on with clean hands and not touched during use; the mask should be removed by the elastic bands at the back to prevent infection - then the hands should be treated to prevent infection. All of this imposes additional conditions on the design and technological requirements for the manufacture of different types of protective masks. Here are the main types of protective masks according to their intended function.

Specialised surgical masks consist of four layers: two outer layers, a filter layer, and a liquid-proof layer. Such a mask can be used for a maximum of two hours. It protects the wearer and the environment from large droplets of liquid, splashes, aerosols and the transmission of airborne pathogens.

Procedure masks are also disposable masks that should also be worn for a maximum of two hours. They consist of three layers: two outer layers and one filter layer. The mask protects the wearer and the people around them from the transmission of pathogens, but, like a surgical mask, it does not provide reliable protection against viruses. Procedural masks are typically used by healthcare professionals and patients in medical facilities. They are also worn during an epidemic in crowded places.

Reusable respiratory masks with an exhalation valve for liquid removal are more durable. They protect against small airborne particles and the transmission of pathogens by airborne droplets (but only the mask wearer, not the environment). They can be used several times, provided they are properly disinfected (but not for more than two hours at a time): the mask can be left outdoors in dry weather for 3-4 days or sterilised in a thermostat or thermal cabinet. Respiratory masks are used to work with increased exposure to harmful substances, as well as during an epidemic. There are several types of such respirators: dust masks; masks that protect against harmful substances and partially protect against viruses; masks that retain up to 95% of harmful substances and viruses. For example, PITTA masks have three protective layers: two outer layers (made of cotton) and one filter layer (made of polyurethane). If they are properly disinfected, they can be reused. Such masks are useful for use during an epidemic and protect the wearer and others from the transmission of pathogens, but not from viruses. We should also mention homemade masks - if you can't buy a protective mask, you can make one yourself. You need three protective layers: two outer layers (at least four layers of gauze each) and one filter layer made of cotton wool. Such a mask can be worn for no more than two hours, and it will only protect against small airborne particles and adverse weather conditions.

The most widely used personal respiratory protection equipment is a surgical mask, consisting of one or more layers that protect the respiratory system from hazardous or potentially hazardous factors. It can be made of various textile or nonwoven materials with different physical properties. The mask is attached to the face with an elastic band, cords with clips, etc.

In accordance with the research problem, we set the task of justifying the choice of a 3D scanner with appropriate software and widely available operating systems for digitising/scanning personal respiratory protection equipment on the face based on an analysis of the characteristics of devices available on the Ukrainian market. Anthropometric measurements of a person's head and face are used for the modern design of different types of masks; the results are processed using modern methods. Based on the analysis of scientific papers, we have identified different approaches to the informed choice of different technologies for digitising the human face. In research, medical and commercial applications, expensive stationary 3D scanning systems are most often used. Among them, a widespread/known high-tech system for obtaining highly detailed and accurate three-dimensional images of the human face is 3dMDface [1]. However, studies by foreign scientists have argued that it is possible to use less expensive and easier-to-use systems to perform tasks for which accuracy is not a key factor. On iOS mobile devices, such as the iPhone X or more recent models, 3D scanning can be performed using applications and sensors, in particular by using LiDAR technology [2] and TrueDepth, which uses a NIR (Near Infrared) sensor with infrared LEDs to create a face point cloud that stores the three-dimensional coordinates of

surface points. This allows for the creation of detailed 3D facial models used, for example, for device unlocking, animation and AR applications.

Conclusions

The research has proven that the current development of the design of protective face masks using 3D scanners and innovative printers indicates the high potential and prospects of this technology for improving the quality of life, health, safety, comfort, and aesthetics of the environment through the application of creativity and innovation in design practices. The basic requirements for the design of protective masks have been identified in order to encourage designers and engineers to find and develop new solutions that meet current and future challenges and changes in society, science, technology, politics, and other areas.

References

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