## ЖАРАТЫЛЫСТАНУ ЖӘНЕ ТЕХНИКАЛЫҚ ҒЫЛЫМДАР

## NATURAL AND TECHNICAL SCIENCES

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# GAMIFICATION OF MEDICAL PROCESSES

**Abstract.** Nowadays, almost all areas of activity are switching to digital format. Medicine is no exception. Treatment is often not the most pleasant process, but it is certainly necessary. In medicine, the use of VR technologies is very popular. They help patients get distracted and immerse themselves in a world where they restore their health during the game. Treatment in the form of games is often more effective than traditional treatment. In this article, we have studied the methods of gamification of rehabilitation after certain diseases. Also, we developed a game prototype for the rehabilitation of hands using Leap Motion technology. Modern games are becoming more and more perfect in terms of game mechanics and content, which makes it possible to use them not only in the gaming industry, but also in the field of medicine.

**Keywords:** gamification, virtual reality, augmented reality, Unity 3D, Leap Motion.

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**Аңдатпа.** Қазіргі уақытта барлық қызмет салалары сандық форматқа көшіп жатыр. Медицина да бұл салалардың қатарына кіреді. Емделу процессі көбінесе жағымсыз болғанына қарамастан, адам өмірі үшін аса маңызды. Медицинада VR технологиялары жиі қолданылады. Олар науқастарға ойын барысында өз денсаулығын қалпына келтіруге ықпал етеді. Емделудің ойын түрі оның дәстүрлі әдістерге қарағанда тиімділігі жоғары. Бұл мақалада біз кейбір аурулардан кейін оңалтудың геймификациялау әдістерін зерттедік, сондай-ақ, Leap Motion технологиясын пайдалана отырып, науқастың қолдарын оңалту үшін ойын әзірледік. Қазіргі заманғы ойындар механикасы және мазмұны тұрғысынан дамып келеді. Бұл, оларды тек ойын индустриясында ғана емес, медицина саласында да пайдалануға мүмкіндік береді.

**Түйін сөздер:** геймификациялау, виртуалды шындық,

толықтырылған шындық, Unity 3D, Leap Motion.

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**Аннотация.** В наши дни практически все сферы деятельности переходят на цифровой формат. Медицина не является исключением. Лечение – это зачастую не самый приятный процесс, но, безусловно, необходимый. В медицине очень популярно использование VR технологий. Они помогают пациентам отвлечься и погрузится в мир, где в процессе игры, они восстанавливают свое здоровье. Лечение в игровой форме зачастую имеет более высокую эффективность в отличие от традиционной. В этой статье мы изучили методы геймификации реабилитаций после некоторых заболеваний, а также, разработали игру для реабилитации кистей с использованием технологии Leap Motion. Современные игры становятся все совершенней в плане игровой механики, содержания, что дает возможность использовать их не только в игровой индустрии, но и в сфере медицины.

**Ключевые слова:** геймификация, виртуальная реальность, дополненная реальность, Unity 3D, Leap Motion.

*Introduction*

Medicine is one of the most important branches of scientific activity, the purpose of which is to study various types of diseases and find ways to treat them. It has a long history of development, dating back to ancient Egypt. In medicine, the processes of treatment, rehabilitation are often unpleasant, and sometimes painful. Only one thought keeps the patient from discontinuing such courses of such treatment - recovery. Treatment is not an easy process and does not bring any pleasure to people undergoing this treatment. How can we make the treatment or rehabilitation process more exciting and interesting?

Fortunately, we live in an age of rapid development of computer technology, which every day is expanding its functionality and covering more areas of activity, including entertainment. Computer games are very popular for a long time, and entered the lives of people as one of the ways to spend free time. Games attract people, allow them to escape from reality and stay in a world where they can receive rewards for certain actions. By combining medical processes with computer games, it is possible to gamify them. So, gamification is mean applying approaches specific to computer games in non-game processes in order to increase the involvement of users in some process.

The implementation of computer games in physical therapy is motivated by characteristics such as attractiveness, motivation, and engagement, but these do not guarantee the intended therapeutic effect of the interventions. Yet, these characteristics are important variables in physical therapy interventions [6].

A large role in the development of gamification in medicine is played by virtual reality technologies. Experts note the high effectiveness of virtual reality

for working with post-traumatic syndromes in patients, and also help reduce anxiety in patients with cancer, especially in children. Virtual and augmented reality is actively used during the rehabilitation of patients who have experienced limb loss. After surgery, many of them experience pain and a feeling of tensed muscles in that part of the body that is no longer there. In this case, doctors turn to augmented reality technologies so that patients can see their lost arm or leg and are able to gradually rebuild the brain so as to reduce the feeling of constant tension.

The uses of virtual reality, augmented reality and mixed reality are spread across multiple fields: education, military, medical fields, entertainment and many others [5]. These technologies become one of the significant discoveries of people. VR includes a computer-based technology that captivates the user in a factitious computer-generated world. This is typically supposed to generate a virtual environment for the user [3]. Initially, they were used for entertainment purposes, but over time the range of applications of these technologies has expanded. It can now be used in the film industry, sports broadcasting, education, tourism and others.

Augmented Reality is often used through means of technological devices such as phones, headsets, glasses, iPads and other interactive technology that allows the user to take the real world through the device used and enhance features, almost using the technology as an "overlay" to the real world. Although Augmented Reality has similarities to Virtual Reality, it is important to highlight that AR should not be confused with the concept of VR. VR replaces reality, whereas AR enhances it. AR occurs as a result of VR and actual reality merging [3].

There are many different devices that can be used in rehabilitation. In this work, we have considered the Leap Motion controller as a device for hand rehabilitation. We created a prototype game on the Unity platform, during which the patient will have to do various exercises with their hands to develop them. Here, Leap Motion used to track hands and gestures. All 3D elements were modeled in Unity 3D and Autodesk Maya.

*Main part*

What technologies exist now that can improve medical processes? Augmented and virtual reality technologies, motion capture technology, controllers with sensors and various applications for smartphones. Using each technology as a game solution for rehabilitation is a separate treatment method for patients with a specific diagnosis. After all, each patient needs his own approach and the most suitable method in rehabilitation through games.

Let consider what method of game rehabilitation can be applied to patients suffering from cerebral palsy. Cerebral palsy characterized by violation of voluntary movements or poses. In other words, such patients have impaired motor activity. One of the stages of treatment of this disease is therapeutic gymnastics. The patient should perform physical exercises for rehabilitation and

prevention of the disease. In order to make this process more fun and not boring, we can use the game “Wii Sports” created for the console “Wii”. This game is a sports simulator of games such as tennis, boxing, baseball, golf and bowling. Simulators work with the motion sensor “Wii Remote” and “Nunchuk”. The patient can control the movements of the bat, putter with one controller, or use two controllers in a boxing simulation. Due to this amazing solution patients have increased level of physical activity and improved their control of movements.

Another method is rehabilitation with Kinect. it has to be mentioned that two types of data can be extracted from the Kinects. The first is simply the raw data returned by the depth camera. The other type is called the skeleton stream, but it also uses the depth camera of the Kinect. “Jewel Mine” - a game created for Kinect, in which patients traveled in a cart through the underground labyrinths and had to jump on time to one of the free tracks, simultaneously extracting gems. This game is used to train the balance of the upper limbs. The big advantage of using Kinect technology in rehabilitation is that it can be adapted for each patient. Because different diseases require appropriate solutions.

Injury and geriatric complications, such as stroke can all cause hand dysfunction, totally or partially, which directly diminish the quality of life. Sometimes it requires a long term therapy to restore the total functionality of hand, which sometimes very molesting process for patients [2]. To restore these functions of the upper extremities, it is necessary to perform a number of special exercises. Long-term rehabilitation is often the only way to recover, as completely as possible, these lost skills. To be effective, this type of rehabilitation should follow three main rules. First, rehabilitation exercises should be able to keep patient's motivation high. Second, each exercise should be customizable depending on patient's needs. Third, patient's performance should be evaluated objectively [4]. Stroke remains one of the leading causes of disability throughout the world. In 2013, it was the third greatest cause of disability, having been responsible for 113 million disability-adjusted life-years [1]. In order to make this process more fun, we developed a game on the Unity 3D using Leap Motion technology.

Leap Motion is a small and compact device capable of capturing movements and thus providing interaction between a person and a computer. Since the use of Leap Motion requires hand gestures, it is excellent for rehabilitation of patients with upper limb dysfunction. In the game, patients need to interact with a 3D object in a virtual space and complete some tasks that aimed to train their upper limbs.

It’s working part positioned up, creating a 3D interaction area. Inside this area, Leap Motion tracks the movement of user’s fingers and hands. The device consists of two cameras and three infrared LEDs. These track infrared light with a wavelength of 850 nanometers. The Leap Motion Controller’s viewing range

is limited to 60 cm above the device. This range is limited by LED light propagation through space, because it becomes harder to detect hand position in 3D beyond a certain distance. The device's USB controller reads the sensor data into it's local memory and performs necessary resolution adjustments. After that, the data is streamed via USB to the Leap Motion tracking software. Because the Leap Motion Controller tracks in near-infrared, the images appear in grayscale. Intense sources or reflectors of infrared light can make hands and fingers hard to distinguish and track. The Leap Motion Controller doesn't generate a depth map. Instead, it applies advanced algorithms to the raw sensor data.

Unity - The most popular engine for creating 3D and 2D games is Unity 3D. It is also good choice for creating medium difficulty projects for both PCs and mobile devices. Unity was originally intended exclusively for Mac computers. In the next versions, new platforms were gradually added. The presence of a large number of ready assets, including scripts, is one of the advantages of Unity 3D. It became the industry leader, and as soon as a new gaming and graphics technology appears, the developers immediately implement it in Unity. Unity works almost everywhere - on all PC operating systems, Android, iOS, browser, VR, console, etc.

*Conclusion*

From a psychological point of view, people are constantly striving for achievements, recognition and waiting for a positive assessment of their actions. Such aspects of the game as a sense of victory, participation in competitions allow people to feel more confident and motivate them for new achievements. Elements of gamification can turn activities such as training, shopping, or the healing process into an activity from which people can get returns in the form of bonuses, points, or other achievements. This further engages patients in the treatment process and it becomes more interesting.

The main objectives of this paper are: 1) to identify and explore technologies that can help gamifying rehabilitation processes; 2) create a game for people who suffer from dysfunction of upper limbs using Leap Motion controller and Unity 3D. This game include levels with different scenarios and task to develop patient's hands.

Spending hours playing computer games is not just for professional gamers. There are people for whom virtual reality immersion is specified by their doctor. Their success in the game depends on much more than reaching a new level. For them, virtual reality is a simulator that increase their quality of health. Thousands of people need rehabilitation using virtual reality technologies. Hundreds of them receive such assistance and demonstrate its effectiveness by their own example.

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