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# СИСТЕМНИЙ АНАЛІЗ І ПРОЕКТУВАННЯ ГРИ «ІМІТАЦІЯ СТРІЛЬБИ В ТИРІ»

# SYSTEM ANALYSIS AND DESIGN OF THE GAME «SHOOTING SIMULATION IN A SHOOTING RANGE»

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***Анотація:*** *У статті розглядається системний аналіз та проектування гри «Імітація стрільби в тирі», що є актуальним напрямом у контексті розвитку сучасної ігрової індустрії. Дослідження підкреслює важливість застосування інформаційних технологій для створення інтерактивних продуктів, які поєднують високий рівень графічної деталізації, реалістичні фізичні моделі та зручний інтерфейс користувача. Головною метою роботи є розробка програмного забезпечення для симуляції стрільби в тирі з використанням сучасних інструментів і методів. У межах дослідження визначено ключові вимоги до системи, описано етапи реалізації проєкту, а також запропоновано підходи до вирішення основних технічних завдань.*

*В роботі детально описано вибір інструментів розробки, зокрема використання ігрового рушія Unreal Engine 5 та 3D-редактора Blender. Unreal Engine 5 забезпечує високий рівень графіки, ефективні засоби візуального програмування через систему Blueprint та широкий спектр документації для підтримки розробників. Blender, як потужний інструмент для створення тривимірних моделей, використовується для моделювання об'єктів, таких як мішені та зброя. Вибір цих інструментів зумовлений їхньою доступністю, функціональністю та активною підтримкою спільноти.*

*Методологія розробки гри охоплює кілька етапів: аналіз вимог, проектування архітектури та інтерфейсу, створення програмного коду, тестування й налагодження. У процесі розробки використовувалися сучасні підходи до моделювання фізичних властивостей, що забезпечує реалістичну імітацію пострілу, враховуючи такі аспекти, як траєкторія кулі, взаємодія з об'єктами та акустичні ефекти. Реалістичність звучання досягнуто завдяки інтеграції якісних звукових файлів, які покращують загальне враження від гри.*

*Особливу увагу приділено практичній реалізації основних функцій гри, зокрема вибору зброї, налаштуванню мішеней, використанню оптичного прицілу та реалізації бонусних пострілів за певних умов. Важливим компонентом є інтерактивне меню налаштувань, що дозволяє гравцеві індивідуально коригувати параметри гри. Гра була протестована на різних апаратних платформах, що підтвердило її сумісність із широким спектром пристроїв.*

*Результати дослідження свідчать про можливість використання даного продукту як для розважальних, так і навчальних цілей. Симуляція стрільби може бути корисною для тренувань у стрілецьких дисциплінах та для залучення користувачів до першокласних ігрових механік. Робота підкреслює важливість інтеграції інноваційних технологій у процес створення ігрових продуктів, що відповідають сучасним стандартам якості та зручності. Таким чином, представлена розробка є прикладом успішного застосування сучасних технологій у галузі інтерактивних розваг і демонструє перспективи розвитку таких проєктів у контексті зростання популярності віртуальних ігор та симуляторів.*

***Abstract:*** *The article examines the system analysis and design of the game «Shooting Simulation in a Shooting Range», which is a relevant area in the context of the modern gaming industry's development. The research emphasizes the importance of using information technologies to create interactive products that combine high levels of graphic detail, realistic physical models, and user-friendly interfaces. The main purpose of the study is to develop software for a shooting simulation using modern tools and methods. The research identifies the key system requirements, describes the stages of project implementation, and proposes approaches to solving the main technical challenges.*

*The paper provides a detailed explanation of the choice of development tools, specifically the use of the Unreal Engine 5 game engine and the Blender 3D editor. Unreal Engine 5 ensures high-quality graphics, efficient visual programming tools through the Blueprint system, and comprehensive developer support. Blender, as a powerful tool for creating three-dimensional models, was used to design objects such as targets and weapons. The choice of these tools is justified by their accessibility, functionality, and active community support.*

*The game development methodology includes several stages: requirements analysis, architecture and interface design, code development, testing, and debugging. During development, modern approaches to modeling physical properties were applied, ensuring realistic simulation of shooting, including aspects such as bullet trajectory, object interactions, and acoustic effects. Realistic sound was achieved through the integration of high-quality audio files, enhancing the overall gaming experience.*

*Special attention was given to the practical implementation of the game's core features, including weapon selection, target customization, the use of optical sights, and the implementation of bonus shots under certain conditions. An important component is the interactive settings menu, allowing players to individually adjust game parameters. The game was tested on various hardware platforms, confirming its compatibility with a wide range of devices.*

*The results of the study demonstrate the potential use of this product for both entertainment and training purposes. The shooting simulation can be beneficial for training in shooting disciplines and engaging users with top-tier gaming mechanics. The work underscores the importance of integrating innovative technologies into the process of creating gaming products that meet modern standards of quality and convenience. Thus, the presented development serves as an example of the successful application of modern technologies in the field of interactive entertainment and demonstrates the prospects for developing such projects in the context of the growing popularity of virtual games and simulators.*

**Ключові слова:** Blender, Unreal Engine 5, симуляція стрільби, розробка ігор, розробка шутера
**Keywords:** Blender, Unreal Engine 5, game development, shooter development, shooting simulation

## 1. Introduction

Video game development is one of the largest segments of the entertainment industry. The scale of the gaming industry is comparable to the film industry, for example. And the video game industry has been significantly ahead of it in terms of growth over the past five years. The structure of the gaming industry in terms of the degree of influence on consumers and their involvement in the interactive environment offered by video games, this segment has long been distinguished from other types of entertainment.

A large number of companies and independent teams are engaged in the creation of computer games. Specialists of different professions take part in the development: programmers, game designers, artists, QA specialists, etc. Large professional teams of 100+ specialists are involved in the development of large commercial gaming products. And such projects can cost tens of millions of dollars in development.

However, successful gaming projects can also be implemented by small teams of enthusiasts. This is facilitated by the presence of a large number of open and widespread platforms on the market, high-quality and virtually free engines, platforms for attracting 'people's' investments (crowdfunding), and affordable distribution channels. Game development is currently a hot topic for research and development.

## 2. Analysis of literary data and problem statement

The growth in demand for virtual entertainment can be explained by several factors. The widespread availability of high-speed Internet allows for online gaming and interaction in virtual worlds. The development of mobile devices makes it possible to play anywhere. The popularity of e-sports and professional gaming competitions also supports interest in computer games. Effective advertising and marketing create interest in new products in this area. Socio-cultural changes are making computer games more widely accepted, and the COVID-19 pandemic has increased demand as people spent more time at home and sought entertainment.

Despite its rapid development and popularity, the game development industry faces several significant challenges that affect its functioning and development. Technical challenges are determined by the need to constantly adapt games to new technologies and platforms, which creates difficulties in the process of optimising and ensuring their compatibility with various devices [1-2].

Wilson K. Mizutani, Vinícius K. Daros, Fabio Konin [3] consider the architecture of software for digital game mechanics. Researchers favour architectures that reduce the effort of developing game mechanics. A large number of researchers have been involved in game development, including A. Hamanets [5] and M. Ivanov [6]. And T. Sobolev in his work [4] describes the peculiarities of shooter development.

The gaming industry, while known for its creativity and innovation, faces its own unique challenges. The development of the industry requires constant improvement of approaches to the technical, financial and social spheres of gaming, information leakage and workflow. Developers must be prepared to constantly improve, adapt and find new solutions to overcome these challenges and ensure the continued growth of the game development industry.

## 3. Purpose and objectives of the study

The purpose of the paper is to create a game «Shooting simulation in a shooting range». The program provides the following features: choice of weapon, optical sight, target selection, bonus shots under specific conditions. Use sound files for clarity and realism of the shot. The following tasks were identified during development:

- analyse the state of the issue and determine the role of information technology in the subject area;
- define system requirements and describe the stages of game implementation;

- create a choice of weapons, the presence of a telescopic sight, target selection, bonus shots under specific conditions;
- use sound files for clarity and realism of the shot.

**4. Methods and materials of research**

The research employed a combination of theoretical and practical scientific methods to ensure a comprehensive analysis and implementation of the project. These methods included:

- *Theoretical Analysis.* A systematic review of existing literature and technologies in the field of game development was conducted. Theoretical frameworks from prior studies were used to define the system's requirements and design approach.
- *Comparative Analysis.* Various game engines and tools were evaluated to determine the most suitable platforms for developing the project. *Unreal Engine 5* [7] and *Blender* [8] were chosen based on their capabilities, community support, and suitability for the game's requirements.
- *Modeling and Simulation.* The research applied modeling techniques to design virtual environments and simulate game mechanics. Tools like *Blender* were used for 3D modeling, while *Unreal Engine* facilitated the implementation of physics-based interactions, such as bullet trajectories and target responses.
- *Experimentation.* Iterative development cycles were employed to test and refine individual components of the game. Experiments focused on validating the functionality of the shooting mechanics, sound integration, and overall gameplay experience. Feedback from initial tests guided adjustments to ensure system stability and user satisfaction.
- *Empirical Methods.* Observations and measurements were used during the debugging and testing stages. Empirical data were gathered to assess the performance of the game across different hardware configurations, ensuring compatibility and efficiency.
- *Systematic Approach.* The research followed a structured development process, dividing the project into clear stages: analysis, design, development, and testing. This approach ensured that each aspect of the game was addressed methodically, from conceptualization to implementation.

The research involved the creation of a game simulation, with specific technical and design considerations. The methodology was structured to ensure the realization of the game's functionalities and realism. The following tools were utilized during the study:

- *Unreal Engine 5.* This platform was selected due to its advanced graphical capabilities, user-friendly Blueprint system for visual scripting, and robust support for developers. It facilitated the integration of high-quality graphics and interactive gameplay mechanics.
- *Blender.* A 3D modeling tool used to design and visualize game elements, such as targets and environments. Blender's open-source nature and versatility made it an optimal choice for creating detailed and realistic game assets.

**5. Research results**

Technological advances in graphics and sound: undergoing constant and evolving improvements. In the field of graphics, there are significant improvements in computer graphics, data visualisation and virtual reality. Thanks to greater computing power and advanced graphics processing algorithms, impressive levels of detail and realism are being achieved in images. In the field of sound, there is a development in acoustic technologies, in particular in the areas of real-time sound processing, virtual sound space and sound synthesis. Audio products are being influenced by developments in artificial intelligence, enabling realistic sound effects and advanced voice recognition systems.

The implementation of the game is to create opportunities: the choice of weapons, the presence of an optical sight, the choice of a target, bonus shots under specific conditions. Use sound files to make the shot more visual and realistic. For this purpose, we used:

- *Unreal Engine 5* because it offers superior graphics capabilities, a more intuitive and flexible development environment, the Blueprint system, and better support and documentation;
- *Blender* because it is a powerful and affordable tool for creating 3D models and visualisation. It is free, open source, fully functional, supports various platforms, and has an active community.

Game development consists of the following stages (Table 1).

**Table 1 - Game development stages**

| # | Stage | Description |
|---|---|---|
| 1. | Analysis of game requirements | Identifying user needs and system requirements, developing the structure and functionality of the system, and estimating the scope of work. |
| 2. | Design | The architecture and user interface of the application are developed, and at this stage it is also necessary to choose the means of implementation, in our case it is the *Unreal Editor* environment using *Blueprints*. |
| 3. | Game and models development | Writing a programme code for the functionality of the system, creating stability and full functionality of the game. |
| 4. | Game testing and debugging | The last stage of implementation and includes:<br>- conducting tests to verify that the application is working correctly and to detect errors'<br>- correcting the detected errors and debugging the system;<br>- checking for compliance with security requirements and standards. |

The development began with the creation of *MetaHuman* (Fig. 1) and the configuration of animations in the project. This tool, developed by Epic Games, is one of the most advanced tools for creating realistic three-dimensional characters with a high level of detail. The use of MetaHuman has allowed developers to integrate a virtual character that meets the modern requirements for the graphic component of games.

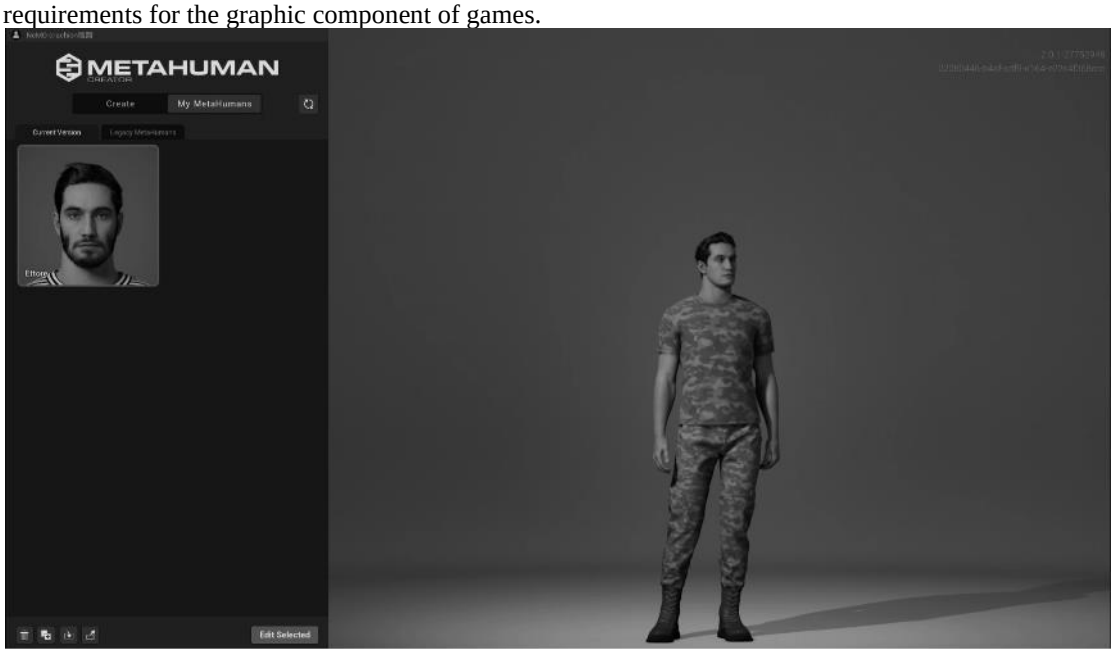


**Figure 1 - The final appearance of *MetaHuman***

The process of creating a character began with the selection of basic characteristics such as physique, facial features, skin texture, and other details that define the character's personality. *MetaHuman* provides the ability to fine-tune every aspect of appearance through a user-friendly interface that allows you to model both unique and standard looks depending on the needs of the project.

After defining the basic look of the character, the animation was implemented. *MetaHuman* has a wide range of tools for creating realistic movements, including simulating facial expressions, limb movements, and overall body dynamics. Thanks to the integration with Unreal Engine 5, the created character can be easily adapted to different game scenarios, ensuring smooth interaction with the game environment.

Special attention was paid to optimising the use of *MetaHuman* in conditions of limited computing resources. Realistic character detailing is combined with optimised polygonal meshing and textures, which allows the created object to be used in environments with medium hardware power.

The next step in the development of this product is to create a weapon system by simulating physics. After that, we move on to modelling the target in *Blender* (Fig. 2).

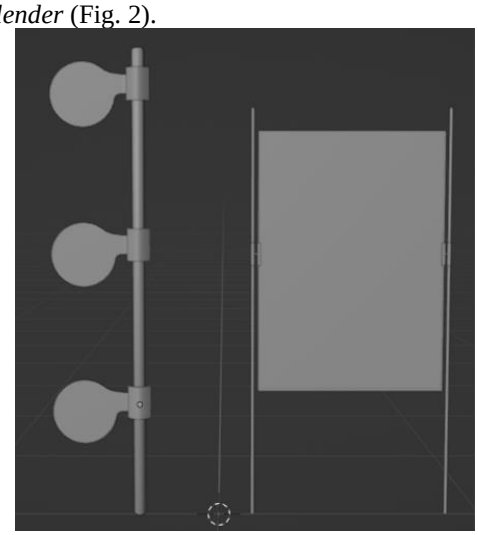

**Figure 2 - The final appearance of targets**

There are several main functions in the game, such as:

- the event of firing a shot (Fig. 3);
- the event of opening the settings menu (Fig. 4).

The event of firing a shot. We create a *line trance* that starts from the player's camera and flies straight until it collides with an obstacle. When it collides with an obstacle, the *Hit* event is called from the *BPI_Hit* interface. If the hit object is a component with *Movable* in the Mobility parameters, it calls the *Add Force at Location* function.

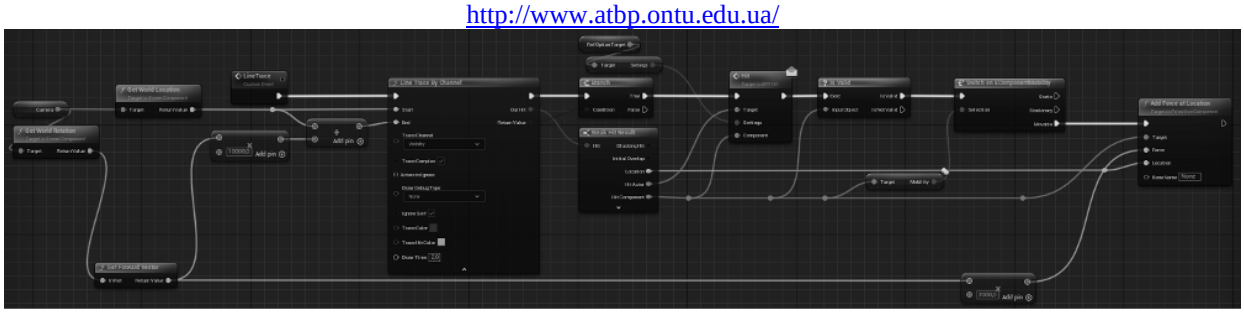

**Figure 3 - The event of firing a shot**

The event of opening the settings menu. A *Bind* is created that will be triggered when the user clicks the «Save» button. The widget with the settings is displayed, the cursor is shown and the user can interact with the widget, and the ability to control the character is disabled.

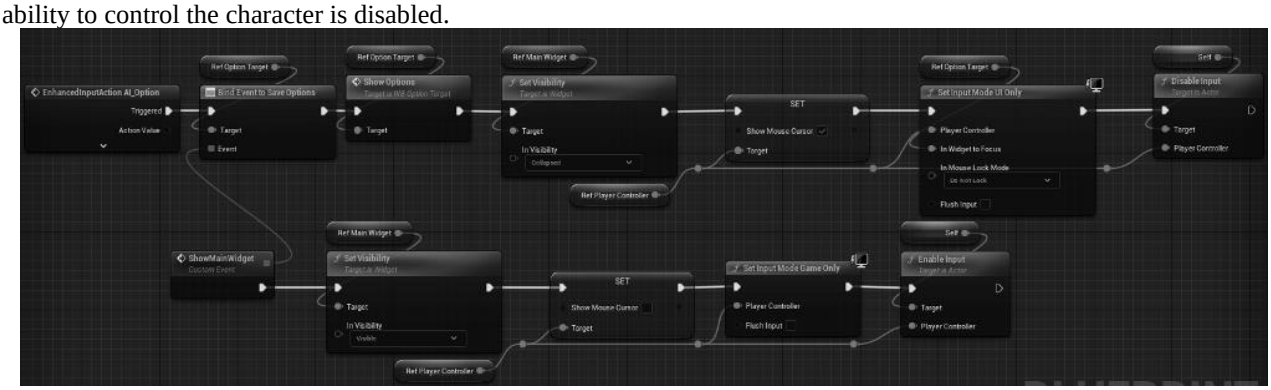

**Figure 4 - The event of opening the settings menu**

This game can be used for training and for shooting in first-person shooters. To install it, you do not need to have a powerful computer, a regular computer will be enough. To use it, go to the folder and find the *.exe* file. It can be used either from the root folder or by creating a shortcut to the desktop.

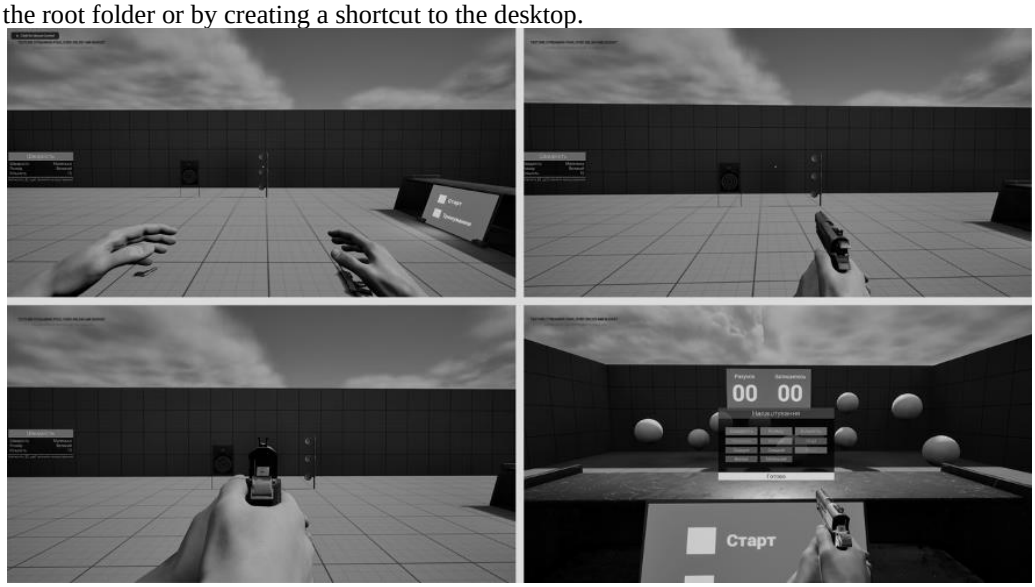


**Figure 5 - The game process result**

First, the player appears on the level. He can raise his weapon by holding down the «F» button. By holding down the right mouse button, you can switch to the aiming mode; by pressing the left mouse button, you will fire a shot. Pressing the «E» button will open the target settings menu. The result of the game is shown in Figure 5.

**6. Conclusions**

As a result of this research, the game "Shooting Simulation in a Shooting Range" was developed, showcasing a high level of integration of modern technologies in game development. A systematic analysis and design process were conducted, ensuring a structured approach to creating the game product. Particular attention was paid to technical and graphical aspects, resulting in the development of a realistic and functional software solution.

The use of tools such as Unreal Engine 5 and Blender confirmed their effectiveness in game development. Unreal Engine 5 provided extensive capabilities for creating high-quality graphics and interactive mechanics through its Blueprint system. Blender offered flexible tools for modeling 3D objects, such as weapons and targets, contributing to the game's high level of detail.

The developed product meets the key requirements of modern games, including realistic simulation of physical processes, interactivity, and user-friendliness. The game incorporates various features, such as weapon selection, target

customization, the use of optical sights, and the implementation of bonus mechanics. The integration of high-quality sound effects added an additional level of immersion for the user.

Significant attention was devoted to testing and optimizing the product, ensuring its compatibility with a wide range of hardware configurations. This broadens the potential audience by enabling the game to run on devices with medium performance levels.

The results of this work demonstrate the potential of using modern technologies to create interactive products. The developed game can be utilized for both entertainment and educational purposes, particularly for training in shooting disciplines. The project highlights the opportunities for further enhancement of game mechanics and adaptation of the product to new user and technology requirements.

Thus, this research not only contributes to the advancement of the gaming industry but also emphasizes the importance of employing innovative approaches in the design and implementation of gaming solutions. The obtained results can serve as a foundation for further research and practical realization of gaming projects of varying complexity.

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