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METODYKA PROJEKTOWANIA MIEJSCA PRACY Z WYKORZYSTANIEM WIRTUALNEJ RZECZYWISTOŚCI

Streszczenie: Testowanie proponowanego rozwiązania w wirtualnej rzeczywistości przed wdrożeniem w świecie rzeczywistym powoli staje się powszechną praktyką w wielu firmach. Jednak właściwa integracja zależy od odpowiedniego podejścia do tworzenia środowiska wirtualnego. W artykule przedstawiono metodykę tworzenia wirtualnego miejsca pracy w bazując o wirtualną rzeczywistością oraz omówiono wszystkie niezbędne etapy postępowania. Przedstawia podstawy zastosowania VR, gdyż dokładna wirtualna kopia stanowiska pracy jest niezbędna do poprawnego wdrożenia rozwiązań opartych na VR w rzeczywistości.

Słowa kluczowe: wirtualna rzeczywistość, metodyka, wirtualne miejsce pracy

METHODOLOGY OF WORKPLACE DESIGN USING VIRTUAL REALITY

Summary: Testing the designed solution in virtual reality (VR) before real-life implementation is slowly becoming a common practice for many companies. However, correct integration depends on correct approach to creation of virtual environment. The article presents the methodology of creating virtual workplace compatible with a virtual reality, explaining every necessary steps. It sets a basis for utilization of VR since a precise virtual copy of designed workplace is vital for correct VR based solutions implementation.

Keywords: virtual reality, methodology, virtual workplace.

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1. Introduction

To succeed in today's highly competitive environment, utilization of key enabling technologies is vital [1]. However, the end result depends on how well these technologies are implemented [2]. Current trends focused on constant cost reduction and verification before real-life implementation [3]. This allows companies to take advantage of these modern technologies.
Virtual reality (VR) brings new possibilities to a process of workplace design and many others increasing their overall effectiveness [4]. Creating copy of a workplace that was just designed or already exist enable companies to verify any changes using virtual environment before its real-life implementation [5]. Moreover, it allows to simulate any workplace process in immersive simulation using VR headset. This requires a creation of immersive virtual workplace with a set level of interaction between user and the virtual objects. Such virtual workplace presents a powerful optimization tool for employee training, simulation, manufacturing system design and many more.
However, all these VR implementations share the same core, the precise virtual copy of a designed environment. Presented methodology provides a unified approach to a creation of virtual workplace, describing each necessary step to create a solid basis for VR utilization in companies and its many departments.

2. Virtual workplace design methodology

The main goal of the methodology is to enable user to create a 3D virtual copy of a selected workplace. This workplace can already exist or is set to be built in a near future. Either way it is necessary to ensure, that created virtual environment match its proposed design or real-life counterpart. It is relatively complex process consisting of several tasks that need to be done. After completion of every necessary step, the user can walk through the created virtual workplace using VR hardware, or even interact with an environment, depending on its purpose.
However, before building a virtual workplace itself, various preparations are required. First, it is vital to determine a main purpose for creating the virtual environment. This will influence the approach and overall difficulty of the project. There are numerous ways to utilize such virtual workplace, such as:

- Presentation of workplace design.
- Process simulation.
- Virtual training of assigned employees.
- Workplace optimization, ergonomics analysis.

These options require additional tasks to ensure their correct functioning. However, the basic principles remain the same. Proposed methodology focuses on these basic principles which are necessary to create a proper virtual copy of a selected workplace. Users then can build on this basis to create virtual environment that suit their needs.
To ensure that methodology is straightforward and easy to understand, entire workflow is visualized through the flowchart. This flowchart shows all the necessary task and requirements for the project's completion step by step. Flowchart is presented at Figure 1 [6].

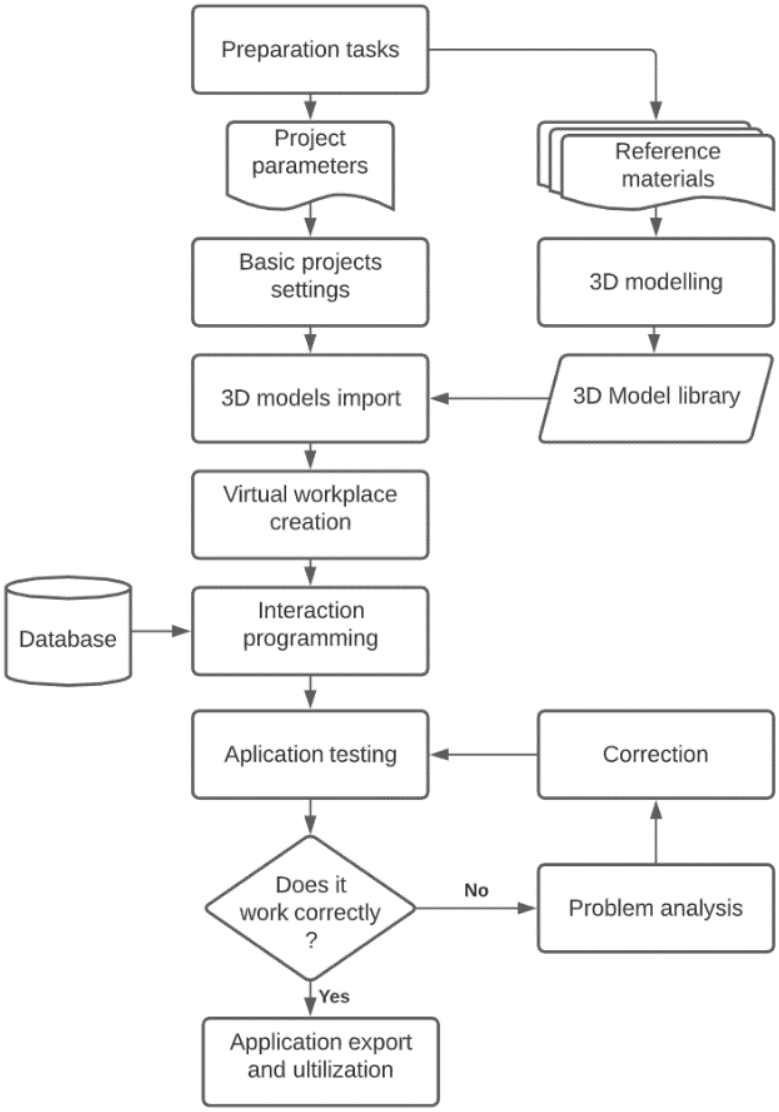

Figure 1. Methodology flowchart [Authors]

2.1. Preparation tasks

Preparation tasks represents the first step before the virtual workplace building itself. Required task differ depending on the planned purpose, but the core remains the same. User needs to analyse presented workplace and determine all means to create a realistic copy. Key part of building the scene is the 3D model library. User may have access to all necessary 3D models, but that will not always be possible. In that case, user must gather needed reference data (photos, dimensions) and create missing 3D models himself using 3D modelling software (Blender, Maya etc.).

Another vital part of the preparation stage is a software selection. It is necessary to choose the software which will be used to create a VR ready virtual environment. One of the possibilities is usage of a game engine, such as Unity 3D. Deciding factor here should be the preferences of the user or the company, while keeping in mind the requirements for creation of virtual workplace capable of VR immersion.
As mentioned before, purpose of created VR workplace is a deciding factor. This plays a key role in choosing the VR hardware, which is the next step. Two most suitable choices are VR headset for desktop or smartphone. Both have their pros and cons, but ultimately it depends on determined utilization of the virtual workplace.
Preparation task should secure all necessary data required for the next stage of virtual environment creation.

2.2. Modelling the missing assets

In a case when user does not have all required 3D objects to reproduce the designed workplace in a virtual environment, it is necessary to obtain all missing objects. Either by outsourcing this task or modelling by user himself.
When modelling, user must keep in mind that these objects will most likely be used to create a complex virtual workplace. This means that models should be adapted to suit such purpose. It is important to find a balance between how detailed these models are and how hard it will be to render them. Best solution is to stick to the basic principles. The objects with most details should be those that are:

- Important to simulate the basic functions of the scene.
- Sizeable, thus easy to notice and examine.
- Ones that user will interact with.

Selection of the 3D modelling software depends on user. Almost every software supports the required formats, so decision based on user preferences should not cause any issue. Figure 2 shows the modelling process in Blender.

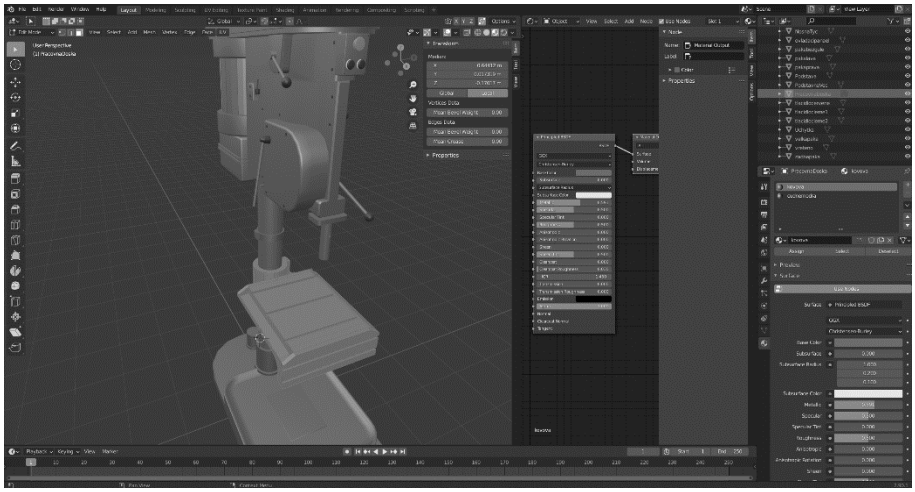

Figure 2. Modelling the missing assets [Authors]

2.3. Projects settings and 3D models import

At this point, user accumulated all required means for creation of selected virtual workplace in a selected software or game engine. But first, it is necessary to match the deciding parameters with projects settings in software. This includes:

- Setting software for VR application on selected platform (Windows, Android etc.).
- Setting software for selected VR hardware.
- Downloading necessary SDKs.

Last part of this stage is then importing every 3D model required for building the virtual workplace matching its real-life counterpart. Doing so may reveal a hidden shortcoming not seen in the modeling software. Thus, it is recommended to check every object before proceeding to the next step. In VR, immersion is important factor, objects on the scene not showing properly may affect the user experience. That is why fixing discovered discrepancies is an important step.

2.4. Virtual workplace creation

After basic setup and importing all objects, the building of the virtual workplace itself is fairly straightforward. It also depends on the chosen software, but most of them offer an intuitive and simple work environment. So, this task may be time consuming, but not complex. User mostly drags and drops models to the scene and places them to match its real-life counterpart. A built-in coordinate system can be used to make that sure all objects are within the correct distance from each other.

The approach for creating a scene depends on the user's preference. However, to prevent unnecessary mistakes and confusion, it is important to create a unified approach for a scene creation. Such approaches may be:

- Placing objects depending on their significance to the scene. For example, the most important objects will be placed first, followed by less significant ones.
- Gradual placing the objects from one side of the scene to the other. For example, placing the objects from left side to the right side. Objects all the way to the left will be placed first.
- Dividing the scene into multiple areas. Each area can serve a different purpose or store different kinds of object. Scene then will be created by building area after area.

User may also design its own approach, depending on his preferences and type of the workplace. Figure 3 shows an example of virtual workplace creation using Unity 3D game engine.

Figure 3. Building virtual workplace in Unity 3D [Authors]

2.5 Interaction programming

Interaction programming stage is definitely the most variable stage. Depending on the project it can be brief or immensely complex. Main goal is to secure the certain level of interaction between player and environment. Interaction level is based on purpose of a virtual workplace. For example, virtual workplace created for visualization of proposed design requires means of movement for a user to explore the scene. On the other hand, a virtual training requires a fully interactable virtual workplace.

In the most cases this will be achieved through programming using programming language, such as C# used by Unity 3D. User needs to know the purpose of the VR scene he is creating and write required scripts accordingly. However, certain scripts are also available online a can be used by user with no programming knowledge.

2.6 Application testing

At the end, it is important to test the final application. Gradually testing the functions of the environment during development is also encouraged. User can build the application and run it with his head-mounted device (VR headset). Depending on a selected platform, he can launch the app on the pc, or export it to the smartphone.

It is vital to find a fix any problems to ensure that the app is running smoothly. Inviting people to test it may bring extra data and new perspective for possible improvements. After perfecting the last details, the app is ready for its designed use. End user will export this app to his device. After launching it with his VR headset on, he must be able to walk through the scene using an assigned controller and interact with an environment to determined extent.

3. Practical use

Functionality of presented methodology was tested in a practical use for virtual workplace design. A bar material processing workplace was designed. But it lacked the means for proper visualisation for upcoming presentation. The main goal was to use the methodology principles to transform a designed 2D layout into VR capable virtual workplace and use it as a visualization tool.
Presentation participants could use the VR headset and controller to walk through the virtual 3D representation of designed 2D layout. This enables them to freely explore the proposed design and see every necessary detail. A simple mobile VR headset was chosen, but for the presentation purpose, which minimize the user interaction options, it is a viable and significantly cheaper method.

3.1 Designed workplace visualization using virtual reality

The process starts with preparation stage of the methodology. This includes analysis of 2D layout and required 3D models, reference collection and software and hardware selection. Next step is modelling of the missing 3D models followed by basic project settings. In this case, Unity 3D game engine was used.
Preparation tasks and 3D modelling were followed by basic project setup and creation of a virtual workplace. Basic setup translates the decision made in preparation stage into selected software for VR environment creation. Subsequently, the designed 2D layout and the imported objects were used to create a corresponding virtual workplace (Figure 4).

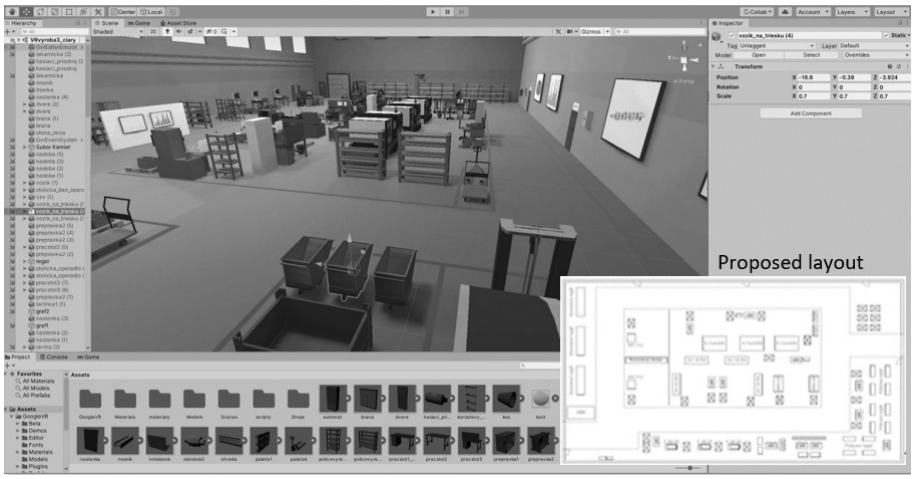

Figure 4. Virtual workplace creation [Authors]

After completing the virtual scene, the means of movement were added. In this case no additional interaction methods were added since main purpose of this virtual workplace is visualization. To ensure a horizontal player movement a script using C# programming language was created:

```
using System.Collections;
using System.Collections.Generic;
using UnityEngine;

public class Ovladanie:MonoBehaviour
{
   public float speed = 3.5f;
   private float gravity = 10f;
   private CharacterController controller;
   void Start ()
   {
    controller = GetComponent<CharacterController>();
   }
   void Update()
   {
    PlayerMovement();
   }
    void PlayerMovement()
   {
    float horizontal = Input.GetAxis("Horizontal");
    float vertical = Input.GetAxis("Vertical");
    Vector3 direction = new Vector3(horizontal,0, vertical);
    Vector3 velocity = direction * speed;
   velocity=Camera.main.transform.TransformDirection(velocity);
    velocity.y -= gravity;
    controller.Move(velocity * Time.deltaTime);
   }
}
```

This script allows player to move through virtual workplace using a controller, which is a vital part of VR presentation of a designed scene.
After completing the virtual workplace including all necessary interaction, the project was built into VR application. At first, application requires testing to fix any occurred problems, then it can be prepared for the final presentation. Figure 5 shows the application itself.

Figure 5. VR application for design presentation [Authors]

4. Conclusion

Virtual reality popularity is steadily on rise. With its many possibilities more and more companies will look for the right way for its implementation into their processes. This methodology presents the principles for creating a virtual workplace from its real-life counterpart or presented design. It leads the user through every necessary steps. From preparations, creating 3D models to testing the scene using VR headset.
To test the methodology capability for practical use, a concrete VR ready scene was created. Main goal was to turn an assigned 2D layout into VR capable 3D environment for visualization purpose. As the result, user created a virtual environment capable of VR immersion suitable for its goal, which was the presentation of proposed workplace.
Methodology proved to be usable in the process of designing a virtual workplace. Further experiment will be conducted to improve overall workflow to make it even more powerful tool in the field of virtual reality.

ACKNOWLEDGMENT

This work was supported by the KEGA Agency under the contract no. 017ŽU-4/2019.

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