

METHODOLOGY OF IMMERSIVE VIDEO APPLICATION: THE CASE STUDY OF A VIRTUAL TOUR

APLIKACIJA IMERZIVNIH VIDEO METOD: PRIMER VIRTUALNEGA OGLEDA

Jure Jazbinšek³³, Gorazd Hren¹

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Abstract

A Virtual Tour is an interactive presentation of real places accessible directly with an Internet browser with no additional installations of apps or plugins. Once, 360° photos are recorded and processed (stitched into spherical panoramas), editing of a Virtual Tour (walk) enables connection of spherical panoramic photos (or videos) into interactive presentations. For an enhanced experience and stand-alone presenting ability, features are added, like natural-sounding voice for text-to-speech descriptions and embedded videos. During multiple virtual tour presentations, users, viewers and presenters reported exceptional usability and an immersive experience. Virtual Tours have great potential to reshape the future education process and establish a new benchmark for presentation. The Virtual Tours application is expected to be used in education, tourism and future building sites or industry, as a key component for workforce briefings, and “as build” documenting of various stages of build, with the possibilities to integrate into Building Information Modelling (BIM) models.

³³ Corresponding author: Jure Jazbinšek, GEN energija, d.o.o., Vrbinca 17, 8270 Krško, Slovenija, tel: + 386 7 49 10 112, Email: jure.jazbinsek@gen-energija.si

¹ Faculty of Energy Technology, University of Maribor, Hočevarjev trg 1, Krško, Slovenia

Povzetek

Virtualni ogled je interaktivna predstavitev resničnih krajev, dostopnih neposredno z internetnim brskalnikom brez dodatnih namestitvev aplikacij ali kakršnihkoli vtičnikov. Ko so 360-stopinjske fotografije posnete in ustrezno obdelane, sledi urejanje virtualnega ogleda (sprehoda), ki omogoči povezavo sferičnih panoramskih fotografij (ali videov) v interaktivne predstavitve. Za boljše izkušnjo in samostojno predstavitev je posameznim panoramam dodan naravni zvok glasu, ki opisuje prostor ali predstavi željeno področje. Po večkratnih predstavitvah uporabniki, gledalci in predstavitelji poročajo o izjemni uporabnosti platforme. Virtualni sprehod ima zaradi poglobljene izkušnje velik potencial za preoblikovanje novodobnega izobraževalnega procesa in vzpostavitev novih meril predstavljanja. Pričakuje se, da se bodo virtualni ogledi uporabljali predvsem v izobraževanju, turizmu, na gradbiščih prihodnosti ter v industriji kot ključna tehnologija za napotke delovni sili in dokumentiranje različnih stopenj gradnje in razvoja z možnostjo vključitve posnetkov v modele gradbenega informacijskega modeliranja (BIM).

1 INTRODUCTION

The COVID-19 pandemic has had a significant impact on all sectors of business. The development of the information society and the universal access to modern technologies have resulted in a new form of participation in business. The creation of virtual space may take place using several forms of presenting data and publishing them on the Internet. These include exploring the virtual spaces through geoportals (including 3D geoportals), Virtual Tours and electronically accessible videos, which are appropriate for the information societies.

In this paper we are focused on Virtual Tours, also called virtual walks. Studies on and explanations for this issue are available mainly on the Internet. In the literature [1-4] authors understand them as multimedia presentations containing high quality panoramas, thanks to which it is possible to see a given place as close to reality as possible. The viewer can look around, admire the perspective and specific details, move between specific locations, zoom in or out and move in selected directions. The purpose of this form of presentation is to give the user the impression of being in each place. Thanks to the use of multimedia solutions, it is possible to attach voice and text effects. The development and evaluation of a Virtual Tour prototype were performed mainly for tourist destinations [2,5] (museums, sightseeing, etc.).

In the new, COVID-19 time, the Education and every-day Communication has taken a sudden swing towards digitalisation. The established routines of standard meetings and classroom presentations were not possible during lockdown periods. A few new platforms for communication have arisen, but for presenting anything to partners or students, MS PowerPoint is still a standard. With the lowering cost of 360 photography and more processing power and connectivity, new platforms for 3D Virtual Tours have risen to their potential. The option to simplify the process of taking high-quality 360° photos, edit them, arrange them in a Virtual Tour, add interactive features and attach media files and publish them, is still a semi-complicated process. New 3D editing programs that will enable simplification of this process will establish a new sandbox for education, presentation of infrastructure and equipment and other fields of use.

Panoramic, or wide format photographs, are pictures that depict horizontally elongated fields of view, or pictures that depict a field of view that is wider than the natural human field of view. It

can be classified into 3 types: The cylindrical, spherical/cubical and planar panoramas, and all 3 types can be either conventional 2D or stereoscopic.

Spherical panoramas are used for virtual-reality purposes, and they show the entire field of view from a single point, 360° horizontally and 180° vertically, allowing the viewer to look in every direction. The image is wrapped into a sphere and viewed from the centre. The horizontal and vertical directions of a spherical panorama are

distorted when flattened. A spherical panorama can be flattened and stretched to become cubic, each cube face representing a planar image that looks normal to the human eye.

Cylindrical panoramas, used primarily in stills photography, depict a 360° horizontal field of view that has vertical constraints, depending on the equipment used or the editing of the image. If flattened out, straight horizontal lines become curved, while straight vertical lines remain straight. There are two types of cylinder panoramas. In the case of inner-cylinder panoramas the setting of the camera stays fixed, and the picture is captured by rotating the 360° camera. In the case of outer-cylinder panoramas the subject is kept fixed and the camera takes photos of the whole circle of the subject. A cylindrical panorama is intended to be viewed as if it were wrapped into the shape of a cylinder and viewed from within.

A Planar panorama is a panoramic photo that is produced by the combination of a series of frames. This method is used mainly in cases where the other two methods cannot be used (e.g. streets or building groups). The camera is positioned halfway along the subject until the whole subject is captured.

Stereoscopic photos are pairs of images, taken simultaneously with two lenses corresponding to the two human eyes, looking in the same direction. When viewed with a stereoscope, such as a View Master, these images create an impression of depth and solidity, and give viewers the impression of seeing a 3D space. This can be applied to the case of panoramas of any type, with the combination of a pair of 360° images, which, when viewed with synchronised Panorama viewers, present a stereo pair. The most popular stereoscope for viewing stereo panoramas is a virtual reality headset.

1.1 Virtual Tours

A Virtual Tour is a simulation of an existing area, usually composed of a sequence of still images or videos, showing the geometrical properties of the location, and supplying information via multimedia, giving users a wrap-around feeling and the impression that they are navigating locations and experiencing them in real time [6]. In using techniques and characteristics that represent a location accurately, namely the exact depiction of all entities (e.g., buildings, objects, facilities), the precise layout, and a high level of interactivity with the user to control and navigate in the virtual environment freely, a virtual tour can manage to provide the user with an experience similar to visiting the real location. Design guidelines for immersive video applications, with an application example, are listed in [7] for a cultural heritage virtual tour.

Google Street View is an innovative Virtual Tour application that was launched by Google in May 2007, can be found in both Google Maps and Google Earth, and provides 360° horizontal and 290° vertical panorama street level views of the surrounding area of a certain spot.

It is a creation of interactive 360° virtual tours with 360° views (panoramas), 360° videos, embedded sounds, videos and photos, floorplans and fully customisable frames. It has the ability of presenting the recorded space with multifunctional hotspots and clickable objects that the audience can explore when walking through the tour. Virtual Tours can be seen on any computer, tablet, or phone (Android & iOS) - no installation or plugins are needed, Online or Offline, they are VR compatible. The application has shown enormous usability during the time of restricted gatherings due to COVID-19 restrictions, and was used twice for the purpose of presenting Faculty laboratories to future students.

2 HARWARE FOR 360° PHOTOS

The Full Spherical Camera model RICOH THETA Z1 presented in *Figure 1* was used for shooting Virtual Tours.



Figure 1: Full Spherical Camera model RICOH THETA Z1

The camera is capable of shooting videos with 4K resolution (3840×1920 with 30 FPS). It has an internal memory of 19 GBs, which can store 350 photos in RAW format, 2400 photos in JPEG format or 40 minutes of 4K video (max. 5 minutes time per recording). The full specifications of the RICOH THETA Z1 are presented in Table 1 [8].

Table 1: Specifications of the Full Spherical Camera model RICOH THETA Z1 [2]

Name of product:	RICOH THETA Z1
Lens F number	F2.1, 3.5, 5.6
Object distance	Approx. 40 cm - ∞ (from the front of the lens)
Image Sensor Size	1.0- inch type (x2)
Image Sensor Effective Pixels	Approx. 20 M (x2)
File Size Still Images	RAW: 7296×3648 JPEG: 6720×3360
File Size Videos	4K: 3840×1920/29.97 fps/56 Mbps 2K: 1920×960/29.97 fps/16 Mbps
File format	Still image: RAW (DNG)*2, JPEG (Exif Ver. 2.3)Video: MP4(Video:MPEG-4 AVC/H.264,Audio: AAC-LC (monaural) +Linear PCM (4ch Spacial audio))Live Streaming: Video: H.264, Audio: Linear PCM (4ch)
Recording medium	Internal memory: Approx. 19GB
Number of photos that can be recorded, time	Still image: RAW+ Approx. 350 photos, JPEG Approx. 2400 photosVideo (time per recording): Max. 5minutes/Max. 25 minutes*3*4Video (total recording time): (4K) Approx. 40 minutes, (2K) Approx. 130 minutes
Shooting mode	Still image, Video: Auto, Aperture priority, Shutter priority, ISO priority, Manual*3Live Streaming : Auto
Shooting Functions	Still image: Noise reduction, DR compensation, HDR Rendering, Interval

To be continued

Continuation

	shooting, Interval Composite shooting, Multi bracket shooting, Self-timer (2, 5, 10 sec.), MY SettingsVideo: Self-timer (2, 5, 10 sec.), MY Settings
OLED Panel	0.93 inch Organic Light Emitting Display Panel,128x36 dots, Automatic brightness adjustment function
Wireless Communications Standard	IEEE802.11 a/b/g/n/ac (2.4 GHz/5 GHz)*5, IEEE802.11 b/g/n (2.4 GHz Only), Bluetooth 4.2
External interface	USB Type-C, USB3.0
Power source	Lithium ion battery (built in)
Battery life	Still image: Approx. 300 photos*7 Video: Approx. 60 minutes*7
Exterior/external dimensions	48 mm (W) x 132.5 mm (H) x 29.7 mm (24 mm)
Weight	Approx. 182 g
Usage temperature range	0°C - 40°C

The camera has two image sensors, and was set with custom macro to shoot multiple (4) snapshots for every location: 1x JPEG (6720x3360 pixels) and 3 snapshots in RAW mode (7296x3648 pixels). The recorded 360°snapshots were merged in the program Adobe Lightroom, in order to achieve more realistic colours, and, finally, stitched into a single spherical 360° photo with the specially dedicated 3dVista plugin software.

3 SOFTWARE FOR THE CREATION OF A VIRTUAL TOUR

The Multimedia Virtual Tour was created with the software 3dVista VIRTUAL TOUR PRO, which enables stitching 360°panoramas and connecting multifunctional hotspots and clickable objects that a user discovers when walking through the tour.

A Virtual Tour lets you see a place on the screen in a way that is most like experiencing it in real life. Virtual Tours can generally contain many different types of media and tools, such as photos, panoramas, videos and audio. Technically, a Virtual Tour is the transformation of a flat panorama image into a spherical format. The Virtual Tour allows the viewer to walk virtually through the recorded scenery using his computer, TV or mobile phone. Within this Virtual Tour you can show panoramas, videos, photos, floor plans or maps, and you can play different sounds, depending on where your viewer looks (immersive audio).

The 3dVista Virtual Tour Suite enables creation and publishing of spherical Virtual Tours that will give viewers the impression of being in the room. They can then pan around, look up, down, left and right, and feel like they are actually in the middle of the scene. On top of that, you can add interactivity, audio, photos, videos and much more, to enrich the experience. [9]

Once, 360° panoramas of laboratories were merged from 3 360° photos with various exposure times, colour corrected in Adobe Lightroom and stitched, but now, the assembly of a Virtual Tour takes place in 3dVista VIRTUAL TOUR PRO. Hotspots buttons (clickable objects) that connect panoramas should be added to define transitions between the presented content (another panorama, text, video, ...) – an example of the workflow of 3dVista VIRTUAL TOUR PRO, where hotspots between panoramas are edited, is presented in Figure 2.

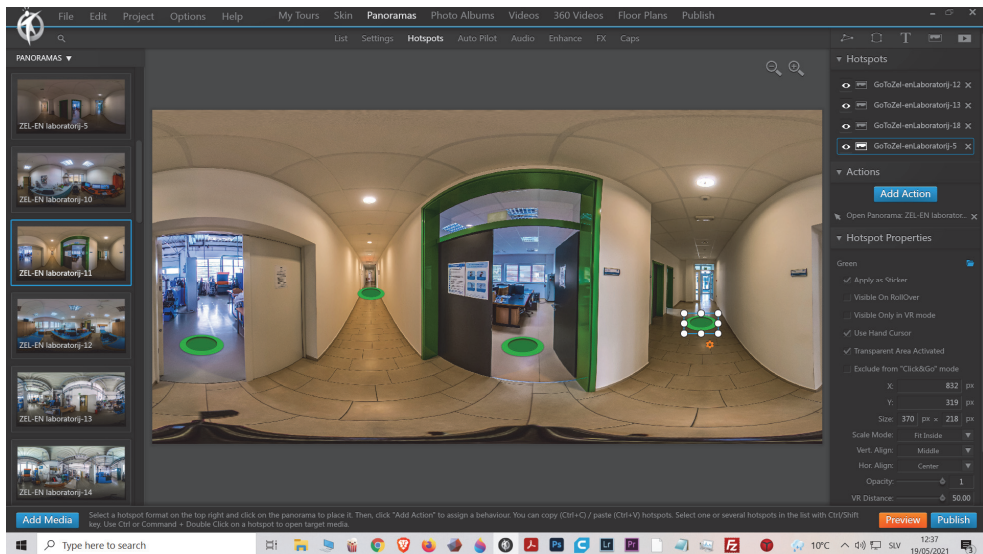


Figure 2: Example of the workflow of the 3dVista VIRTUAL TOUR PRO

4 TEXT TO SPEECH

The Text to Speech Feature converts any written text inside your Virtual Tour into spoken words, so it reads digital text aloud. This is not only useful in terms of Web accessibility, where alt text options are essential for people with disabilities, such as blindness or dyslexia. It's useful for all Virtual Tour visitors. Content can be read aloud for people who prefer to listen, for example, while navigating the tour rather than having to stop and read a whole lot of text. This is particularly useful for users exploring the Virtual Tour in VR or AR headsets, which are simply not meant for reading texts.

4.1 3D Vista Text to Speech

The Text To Speech feature can be applied to all sorts of text you can find in a Virtual Tour. It can read out info window texts, tool tips, buttons, or even play an audio description of the current media, within a panorama, or even a 360° video. [10]

4.2 MS Office Text to Speech

Speak is a built-in feature of Word, Outlook, PowerPoint and OneNote. You can use Speak to have text read aloud in the language of your version of Office. Text-to-speech (TTS) is the ability of your computer to play back written text as spoken words. Depending upon your configuration and installed TTS engines, you can hear most text that appears on your screen in Word, Outlook, PowerPoint and OneNote. For example, if you're using the English version of Office, the English TTS engine is installed automatically.

MS Office Text To Speech offers reading in the Slovenian language (Pregled / Govor / Glasno branje) with the voice option name Microsoft Lado, and only the most basic option of adjusting the speed of reading is available.

4.3 MS Azure Text to Speech

There are some limitations with the supported languages in the Text To Speech Feature and the Slovenian language is not yet supported as an option. This challenge was solved with the Microsoft Azure - Text to Speech demo application, built on JavaScript SDK and available free online. [11]

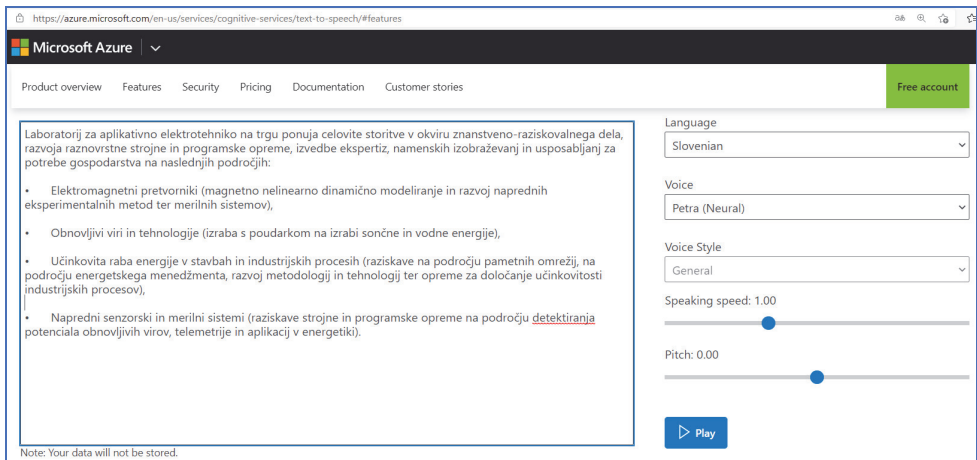


Figure 3: Example of using MS Azure

There are three options to choose from in Azure Voice options: Petra and Rok (both are Neural voices) and the voice Lado from the basic MS office option. Next to settings of the Speaking speed, it is also possible to adjust the Pitch of the chosen voice (Figure 3).

The Microsoft Azure - Text to Speech demo app gives the best loud reading results of the Slovenian language but does not allow saving speech as a recording directly. To solve this, the Windows 10 Game Bar was activated, and a video of the screen was recorded during the Text to Speech. The recorded mpeg4 file was then converted to an mp3 file with the VLC player.

4.4 Publishing a Virtual Tour

At the end of the editing process, the Virtual Tour needs to be published to a web server to share users easily via the Internet. Using the 3dVista hosting service is the easiest way to get your Virtual Tour online. This is an optional service to upload a Virtual Tour fast and easily, a service which is paid for annually for the hosting space you contract.

Another option is to upload a Virtual Tour to a server other than the 3dVista hosting service, in which case an FTP client is needed. An FTP client is a program that helps transfer files like the

Virtual Tour file, between the computer and the external server where the domain is located. An FTP client called FileZilla was used, because it is free and easy to use.

4 CONCLUSIONS

Because of COVID-19, there were a lot of restrictions on public gatherings, and therefore it was not possible to perform a lot of typical events, such as information day of Faculties and other laboratory presentations.

A variety of industries use the Virtual Tour technology to help promote their services and products. For most business purposes, a Virtual Tour must be accessible from everywhere, therefore, a major solution is a web-based Virtual Tour. Over the last few years the quality and accessibility of Virtual Tours has improved considerably, with some websites allowing the user to navigate the tours by clicking on maps or integrated floor plans. The main areas where this new technology is applied is mainly universities, the Tourism and Culture sectors and the Real-estate industry.

With the help of a 360° camera, 3dVista software and existing material (pdf text, photos, and videos), a Virtual Tour was created of the Institute of Energy Technology located in Krško. Within this Virtual Tour, a user can move between laboratories, inspect laboratory equipment, read technical specifications, watch embedded movies about the Faculty, and even listen to text-to-speech descriptions of laboratories.

With the help of the Virtual Tour of the laboratories, a virtual conference with a virtual walkthrough of the laboratories was performed with great success. The moderator was able to present all the rooms, and the Professors could describe the equipment available and the field of work of every laboratory.



Figure 4: Snapshot from the Virtual Tour

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