Augmented reality in postindustrial tourism

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Abstract. This paper explores the possibility of building an augmented reality (AR) smart system with a certain degree of artificial intelligence in order to recognize the components and their properties from the environment. The elements of the environment can be buildings, access roads, vegetation and so on. All of these can be accessed with AR devices, intelligent glasses, or smartphones displays. The buildings' facades and the access routes, or any other form of geographical relief from the environment, can become triggers for connecting digital content to the real world. The paper presents the different existing applications of AR systems with emphasizes on the tourism field, discussing the potential of further development, the particular aspects concerning the conceptual elements of an AR based model design for postindustrial tourism development.

1. Introduction
Mobile technologies have changed the way people perceive the environment. Various studies show a broad acceptance of the population towards the new technologies of digital realities, whether augmentation, virtual immersion or mixed immersion [1]. The concept of augmented reality exists in the 1960s, but only the technological developments of the last twenty years made it possible to apply it. With augmentation technologies, computer-generated data (different multimedia formats) can be superimposed over real world elements, thus enhancing the user's perception of what is happening around him. Integration of augmentation technologies into tourism will help organizers provide interactive multimedia (audio-video), or guidance and information (graphics and contextual information). This augmentation will lead to the creation of multimedia packages according to the user's preferences, based on the various scenarios that a tourist attraction may provide [3].

The presentation of digital augmentation elements must be made as veridical as possible so that the final result is a natural one as a whole. Digital content must increase the tourist experience as perceived as natural, but, where appropriate, preserve to a certain extent the artificial side.

2. The impact of AR
Several categories of augmented reality technology exist, each with varying differences in their objectives and applicational use cases.

Table 1. Augmented reality technologies.

| Domain  | Application | Characteristics |
|---------|-------------|-----------------|
| Healthcare | Brain Power | Guiding people with mental disorders, especially those with autism, with intelligent glasses. |
|          | AccuVein    | Used handheld scanner and helps providers locate patients’ |
Table 1. Augmented reality technologies.

| Domain         | Application         | Characteristics                                                                 |
|----------------|---------------------|----------------------------------------------------------------------------------|
| Augmented reality technologies. | Viipar | Video support platform for surgeon that functions via Google Glass. |
| Entertainment  | Niantic’s Pokemon GO | Uses real locations to encourage players to far and wide in the real world to discover Pokemon. |
|                | Real Strike         | The users get a real-life shooting experience in this game and can record their fights and also create their own videos. |
|                | Metaverse           | In Metaverse, on computer, you can create or import images or 3D objects from Sketchfab or Google Poly, and in the Metaverse mobile app you can view them as augmented reality objects. |
|                | Elements 4D by DAQRI | Let’s students combine different elements to see chemistry in action. |
| Education      | JigSpace            | You can create and share interactive 3D objects or 3D scenes integrated in eLearning. |
|                | SketchAR            | With the augmented reality and artificial intelligence implemented in SketchAR, users can learn to draw. |
|                | Halifax homefinder  | Depending on location on the map, the app displays the augmenting information regarding the sale or rental price of the dwelling. |
| Retail and Marketing | Argos | Allows customers to experience the latest Lego toys before they buy. |
|                | Amazon              | Presenting 3D scanned products and integrating them into customer space with augmented reality. |
|                | YouCam Makeup       | Makeup with cosmetics of the famous fashion houses. |
| Fashion & Beauty | InkHunter | Performs augmented projections’ on the body, through the mobile phone screen, of virtual tattoos before being permanently inked. |
| Automotive     | Gucci               | The glued posters’ on the windows of Gucci boutiques can be scanned to access products even when the store is closed. |
|                | Find Your Car with AR Tactical Augmented Reality | If you no longer remember where you parked your car, the app can get lead you to your car in the supermarket car park. All the crucial information is being superimposed onto the pilot’s visor, so they do not have to look down at their panels all the time and have much better situational awareness. Is also called Enhanced Night Vision Goggles – Binocular, provides soldiers with a better night sight and tactical information in the form of an overlay. |
| Military       | HUD 1.0             | An AR system that should help train soldiers in a more immersive way, putting them into more physically and mentally stressing operational environments. |
|                | Synthetic Training Environment | With the help of GPS coordinates, some old images or sounds, related to the location of the user at that time can be displayed on the screen used to display augmented reality. |
| Art            | LifeClipper         |                                                                                   |
There are a number of applications for augmented reality in the sightseeing and tourism industries. The ability to augment a live view of displays in a museum with facts and figures is a natural use of the technology.

**Table 2.** Augmented reality used in tourism, classified based on software platform.

| Soft Platform          | Name apps          | Description                                                                                                                                                                                                 |
|------------------------|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| **Dedicated AR devices** |                    |                                                                                                                                                                                                            |
| Archeoguide            | Olympia, Greece    | Head mounted display – used a server system capable of managing the flow of data through a portable computer connected to the server via a network. Use a tracking system based on geo data, able to calculate the position and orientation of the user and locate sufficient data to visualize the digital content in the physical space. |
| LifePlus               | Pompeii, Italy     | Head mounted display – used a geolocation system that could detect the position and orientation of the user’s head in space. This information was processed at a central high-speed computer and sent via wireless to the laptop worn by the user, which included an HDM device and built WebCam. |
| InnoView               |                    | Viewpoint binocular – allows the overlapping of digital content on the actual view that is seen in the background. Several icons relevant to the attractions of the area appear in this binocular view. Has been installed in various areas, such as the Arena shopping centre Barcelona from where you can see the Plaza of Spain and Montjuïc. |
| Virtual Sightseeing   |                    | Touch screen – geo-tag system appears in the user’s vision, fulfilled with information related to the specific location. Was installed near the Environmental Interpretation Centre of Lisbon – to raise awareness about the coastal fauna and flora of the Ciudadela. |
| CodeCabanyal          |                    | App use different navigation system based on the user’s choice: live navigation, navigation map, navigation index, guided car navigation, navigation comments. Was held in the district of Cabanyal in Valencia. |
| **Smartphone**         |                    |                                                                                                                                                                                                            |
| MiraAlicante           |                    | Use the same technology with CodeCabanyal but focus to highlight the important buildings and monument of the city of Alicante.                                                                          |
| Paris, Then and Now    |                    | App in the outdoor environment – tourists are able to “time-travel” and experience sights of Paris how it used to be 100 years ago, for 2000 spots around the city. Cross-platform AR SDK, which supports all mobile phone systems. A user may create AR content using well-known web standards, getting most of HTML, JavaScript and CSS. |
| Wikitude               |                    | AR platform or browser, works by using a combination of the smartphone’s camera, compass and GPS data to identify the user’s location and field of view, retrieve data based on those geographical coordinates, and overlay that data over the camera view. |
| **Browser**            |                    |                                                                                                                                                                                                            |
| Layar                  |                    | New open platform, combines the KML used by Google earth mapping program with HTML.                                                                                                                        |
| KARMA                  |                    | AR tourist guide for Basel, accessible through the Layar AR.                                                                                                                                               |
Table 2. Augmented reality used in tourism, classified based on software platform.

| Soft Platform | Name apps          | Description                                                                                                                                 |
|---------------|--------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| iOS Platforms | [7] Tuscany+       | App delivers tourist information, including accommodation, dining, the city’s Tuscany, Italy, nightlife and sightseeing, by drawing the information from internet source. |
|               | The Street Museum  | App developed for the needs of the Museum of London, offers users the opportunity to visualize the city of London from numerous points of history. |
|               | String [6]         | Vision-based AR SDK for iOS, recognizes framed images and understands where they are in 3D space, and then displays rich 3D graphics on top.       |

3. Methodology

In the real surrounding world, objects are located at different distances, having different forms and physical properties. Thus, they can be seen totally, partially or perceived of different sizes. These surrounding objects can be identified by cameras that provide captured images, by sorting and grading algorithms to determine their location, edges, and static or dynamic physical properties.

If the user is located in a building, the mixed or augmented reality device will recognize the elements of the environment (walls, floors, windows, doors, corridors), and after recognizing them, they will use the properties to move virtual objects or achieve different interactions with real elements, e.g. to place a virtual painting on a real wall. The recognized real elements will be assembled to create the 3D model of the interior of the building. External environments, after scanning, can be assembled in 3D models and saved in interactive online maps online (e.g. Google maps) to be accessed [8]. These 3D models can be integrated into any of the realities from the continuum of realities.

When created, digital objects can be deployed with the same physical, static or dynamic properties to interact with the other objects in the scene, whether virtual or real.

Static physical properties are those properties that describe the object, from shape and color to location on the map. These properties can help to hide objects behind other objects. The mask is created as follows: the intersection between the two contours, the actual recognized object and the known virtual object (Figure 1). The contour of the mask may change depending on the projection that the subject’s real object is. Moving a virtual object (e.g. representing a miner) in front of a real wagon (Figure 2). The further from the viewer are the virtual objects, the smaller they will be.

![Figure 1](image1.png)  
Figure 1. The mask is created by the intersection of the contour of the recognized real object and the outline of the known virtual object.
Figure 2. A virtual object eclipses a real object.

Dynamic physical properties show how objects can interact with each other, real or virtual. Thus, a virtual boat will "float" on a water luster, a plane will "fly" through the air, or if a "virtual object" is placed behind a glass, the object will be affected by clarity and colors.

In Figure 3, the augmented reality device has identified the mine floor as "floor" and that there is a railroad carriageway. Because a virtual wagon can only move on the rails, it is "seated" on those rails and "behaves" like a real wagon, that it can be "pushed" by a real or virtual character, can carry virtual coal and will be able to "attach" to the row of real wagons.

Following the recognition of the real objects in the environment, together with their properties, the virtual corridors of the virtual objects implemented in the surrounding environment can be established. Thus, virtual objects will "behave naturally" by moving on the access paths, bypassing or interacting with real objects. They will pass through the door space in the adjoining rooms and display in the space appropriate to its "real" dimensions.
4. AR System for post-industrial development tourism

4.1. Definitions of industrial tourism
Despite its long history, industrial tourism is not yet a very well-defined concept. Stipanuk [9] came to the conclusion that little was written about industrial tourism, referring to the works of Simonson [10] and Cox & Fox [11]. Some use the term for something completely different: tourism as an industry like Rodenburg [12] and Abbey [13], while others use other terms for phenomena that are more or less equal to industrial tourism. Soyez [14] defined industrial tourism as a specific group of visits to operational or non-operational firms: "any form of movement, both in terms of former industrial and operational systems." Yale [15] defines the concept of industrial tourism as the process of presenting "contemporary manufacturing processes," while Dodd and Bigotte [16] describe industrial tourism as "consumer visits to the production area that may include educational tours of line production and degustation of the product." Frew [17] defines industrial tourism as "tourists' visits to operational sites where basic activity is not tourism-oriented". Steinecke [18] includes the term "industrial experiences in the world" as a cluster of attractions that allow visitors to learn more about past, present and future industries. It would seem that Kelly and Dixon's [19], by describing the term "collateral tourism", were closer than any other author to the current definition of industrial tourism.

The closest definition to our approach is that developed by Otgaar [20] that defines industrial tourism as "site visits that allow visitors to learn about past, present and future economic activities." It provides a broader definition of the concept than previous visions and highlights, on the basis of the literature, that there is no generally accepted definition applicable to industrial tourism.

4.2. Capitalizing on industrial heritage in Romania
A notable interest in the protection of the Romanian industrial heritage is recorded in 1951 when it is decided to draw up an inventory of the monuments. In 1955 the list of cultural monuments is finalized and some monuments of industrial interest have been included on this list. In 1961 it was decided to make a new list of historical monuments, but the documentation for this proposal was more than superficial. In 1974, the County Bureaus for National Cultural Patrimony were established, but there was no thorough and systematic concern about the inventory and preservation of the industrial heritage until 2008 when Law no. 6/2008 on the legal regime of technical and industrial patrimony, a law that recognizes the importance of industrial patrimony, although there is not much action in this regard. At this moment, Romania has no industrial sites listed on the UNESCO World Heritage List.

Over time, there have been several projects related to the preservation of culture, knowledge, tools, equipment, customs, clothing, artifacts related to industrial exploitation in Romania. These efforts have led to the establishment of museums related to the exploitation of natural resources.

Of the former mining operations in Romania, the salt mines manage to successfully achieve the transfer of profitability from the exploitation of the field to the tourist exploitation. Salt exploits are impressive due to the spectacular underground spaces created by salt extraction. The salt mines such as Praid, Turda, Slănic Prahova, Cacica, Ocnele Mari and Targu Ocna have been opened to the public due to the tourist potential they have.

To increase attractiveness in all former salt mines, recreational and relaxation facilities have been set up, such as children's playgrounds, adult rest areas, sports facilities (table tennis, bowling, mini football), restaurant or drinks where beverages can be bought, sanitary facilities, souvenir shop, etc. In all salons open to the public, ecumenical chapels for silence and religious events were arranged. In some salt mines, the old mining equipment was restored, and small exhibitions or museums were set up to present the salt exploitation procedures [21].

4.3. Industrial tourism, boosted by AR, as a tool for revitalizing the Jiu Valley region
The history of the Jiu Valley is certainly linked to the exploitation of coal deposits. In the context of a massive increase in coal demand at the national level, due to the industrialization, the population of the Jiu Valley reached the threshold of 200,000 inhabitants in 1989. Together with the mining industry
and other structures such as educational institutions, research, and industrial activities, ensuring the socio-economic development of the area.

The Jiu Valley coal exploitation situation faced major structural changes after 1989 when Jiu Valley entered a long process of restructuring and reorganization in the context of the industrial decline, materialized in massive layoffs, so the number of employees decreased from 60,679 in 1989 to only 3,767 in the year 2017. If in 1990, in the Jiu Valley there were 15 mining mines, there are currently only 4 of which 2 are scheduled to begin the closure procedures in 2019.

At the 2011 census, the population of the Jiu Valley has 119,484 inhabitants, mainly concentrated in the six mining areas of the region - Petrosani, Lupeni, Vulcan, Uricani, Petrila, and Aninoasa, as well as small villages such as Campu lui Neag, Lonea, and Banita. Industrial restructuring has had major effects in the Jiu Valley's mono-industrial region, resulting in serious social problems in localities such as unemployment, depopulation, the formation of a negative image of the site and turning the entire region into a disadvantaged area, which is why be considered a "problem area", because the degree of dependence on the mining activity is very high. The remaining workforce is poorly qualified, de professionalized or demotivated, and infrastructure is not the strong point of these localities, which is not attractive to investors.

Under these circumstances, it is desirable to develop a strategy for the reconversion of the area through the reuse of industrial patrimony. It is increasingly spoken about the fact that the industrial spaces have their beauty and their suppleness or that, on the contrary, they are cumbersome, but with their own charm. Old industrial premises should not be demolished or abandoned, but rather reconverted, assumed to be interesting, attractive, functional spaces.

In order to achieve this goal, we try to identify the extent to which modern technologies can cause changes in the preferences of tourists. Dozens of hectares deserted or occupied by old buildings, prepared for demolition and decommissioned machinery, remains the testimony of an important milestone for the area, can be transformed by augmented reality into a territory of art [22], a field open to any type of audience, the interest of many types of visitors eager to try another kind of tourism. In addition, it could lead to an increase in the youngsters' interest in the past and cultural heritage.

5. Findings
In this section we’ll present the current state of implementing the augmented reality methods and techniques in a Jiu Valley location, namely former Petrila Mine. First, there are presented two examples of using an augmented reality device for navigating inside a School Mine and for navigating outside on the proposed touristic route.

When a tourist is in the "School Mine" and is heading for the augmented reality device to the back of the "mine" corridor, that part of the corridor is recognized and a multimedia file is launched. It may contain photo, video or audio images. In this case, a photo image, a sequence of an underground miner's work, is displayed [23].

![Image](image_url)

**Figure 4.** The image of the "School Mine" augmented with a sequence of the work of an underground miner.
The augmented reality device screen shows the route and the points of intersection. Various information can be displayed along the way that improves the presentation of the guide, which may be in the form of text or audio-video.

**Figure 5.** Increased representation of the route and points of interest.

**Figure 6.** Map of the proposed route for visiting the Petrila theme park.

In order to be able to implement the use of augmented reality devices, first there was digitized the Petrila Mine site and was proposed a structure for Petrila Theme Park, as follows:

1. **A** - The access path in the perimeter
   - Information centre - located in the former dispensary - here the visitor will receive general information on the important objectives of the touristic circuit as well as various informative leaflets. They will be able to rent from here augmented reality devices with which they will easily unravel the mysteries of the place.

2. **B** - Museum - arranged in the former administrative building that housed at the ground floor the call hall, the lamps office, the showers as well as the underground entrance area and the various offices were at the upper levels. All the area that served the miners’ route, from the entrance to the cage, will be presented in situ, the experience of tourists being enhanced with the devices of reality augmented by the application of digital content over the physical reality, thus re-editing the specific activities carried out in the past.

3. **C** - Qualification school - an educational center where can be observed the halls where the newly employed miners took a part in the theoretical training courses regarding the specific mining activities as well as those referring to the occupational safety standards.
4 - The „School Mine” - a model coal mine, a low-scale underground, will be the strength of the touristic circuit, as it will give visitors the opportunity to get acquainted with what underground and underground work means and to have an experience as close as possible to the realities of miners’ life in coal mines, rewritten by augmented reality [24].

5-6 - Observation points in the perimeter with augmented reality – the mine includes a series of constructions achieved to serve the production process, from extraction to transport the coal production at the treatment plant to the surface: the centre shaft assembly, the old compressor building and the mechanical workshop, the treatment plant and its concrete basins, the coal extraction sector made up of skip shafts, sorting station with silos, the conveyor belts, the angular stations, the ventilating fans and the new compressor building, Deak shaft, the old thermal power station and the chimney, the funicular area, the railway and the tailings dumps [25]. All these objectives will be observed as they were in the exploitation period, with augmented reality devices.

B - Ending the tourist circuit, handing over the rented equipment and leaving the perimeter.

6. Conclusions

Augmented reality technology and system enriches the real world with the virtual objects and scenes, being images (2D/3D), videos, sounds, etc., over the real world. Technically AR involves various technologies including image processing, computer vision, computer graphics and display. It produces a sensation of presence in the real world and not in a kind of synthetic environment that is characteristic of the domains of virtual reality and allows the user to be aware of the surrounding space and for this, it is necessary to have a physical presence at the specific place. This makes the AR a unique tool for tourism and cultural heritage because AR applications provide the opportunity to view and tell stories about the locations and history of the location being discussed.

Enhanced and innovative exhibitions are possible through the collaborative use of augmented reality, the interconnection of collections and physical completion with virtual objects relevant to all participants. In addition to preserving natural and cultural heritage, this collaborative AR approach can generate a wider impact of collections, helping our general understanding, a deeper appreciation, and common knowledge.

7. References

[1] Yovchevaa Z, Buhalisb D and Gatzidisc C 2012 e-Review of Tourism Research 10 63
[2] Dieck M C T and Jung T 2015 Current Issues in Tourism 21 154
[3] Kounavis C D, Kasimati A E and Zamani E D 2012 International Journal of Engineering Business Management 4 1
[4] Mesaros P, Mandicak T, Mesarosova A, Hernandez M F, Krsak B, Sidor C, Strba L, Molokac M, Hvizdak L, Blistan P and Delina R 2016 e-Review of Tourism Research 13 366
[5] Jung T and Han D I 2018 Identifying tourist requirements for mobile AR tourism applications in urban heritage tourism Augmented reality and virtual reality: empowering human, place and business p 3
[6] Tian F, Xu F and Fu J 2013 Augmented reality technology overview for tourism app development Proc. International Conference on Machine Learning and Cybernetics p 1483
[7] Genc R 2018 The impact of augmented reality technology on tourist satisfaction Augmented reality and virtual reality: empowering human, place and business p 109
[8] Tadros M A and Franklin J B 2019 Patent US20190088016A1
[9] Stipanuk D M 1993 Tourism Management 14 267
[10] Simonson L R 1974 A study of industrial plant tours as important tourism attractions Unpublished doctoral dissertation Texas A and M University
[11] Cox L J, Fox M 1991 Journal of Tourism Studies 2 18
[12] Rodenburg E 1980 Annals of Tourism Research 7 177
[13] Abbey E 1968 Desert Solitaire: A Season in the Wilderness New York Ballantine
[14] Soyez D 1986 Industrietourismus Erdkunde 40 105
[15] Yale P 1991 *From Tourist Attractions to Heritage Tourism* p 253
[16] Dodd T H and Bigotte V 1997 *Journal of Travel Research* 35 46
[17] Frew E A 2000 Industrial Tourism: A Conceptual and Empirical Analysis *PhD Thesis* Victoria University
[18] Steinecke A 2001 Industrieerlebniselten: zwischen Heritage und Markt: Konzepte-Modelle-Trends *Hinterhuber, H.H., Perchlaner H. & Matzler K. (Eds.)*
[19] Kelly I and Dixon W 1991 *Journal of tourism studies* 2 21
[20] Otgaar A H J 2010 Industrial Tourism: Where the public Meets the Private *PhD Thesis* Erasmus University Rotterdam
[21] Radu B 2015 Reziliența Fostelor Comunități Miniere *Presa Universitară Clujeana*
[22] Marimón D, Sarasua C, Carrasco P, Alvarez R, Montesa J, Adamek T, Romero I, Ortega M, Gascó P 2010 *MobiAR: Tourist Experiences through Mobile Augmented Reality*
[23] Riurean S, Olar M, Leba M and Ionica A 2018 Underground positioning system based on visible light communication and augmented reality *Proc. 17th edition International Technical-Scientific Conference, Modern Technologies for the 3rd Millennium, March 22-23, Oradea* p 345
[24] Ionica A Leba M 2014 Gamification & Research - Partnership for Innovation, *Proc. Conf. 2nd Global Conference on Business, Economics and Management and Tourism* 23 671
[25] Toderas M and Danciu C 2017 *Quality-access to success* 18 230