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AUGMENTED REALITY - STATE OF KNOWLEDGE, USE AND EXPERIMENTATION

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Abstract:
Technologies for augmenting reality have been consolidated during the last decades, extending their applicability to more and more socio-economic areas. The rapid evolution of mobile technologies and virtualization of the digital environment have created auspicious conditions for massive extension and implementation of solutions for augmenting reality at global level. Experience has already shown that augmented reality, alongside virtual reality can offer very important support solutions in modeling the real world with the aim of extending the human capabilities of perception, allowing the opening of a new phase in the world's socio-economic development. Starting from the evident tendencies that have manifested at global level in the development and implementation of augmented reality technologies, the paper begins with the presentation of the most important aspects related to augmented reality technologies, highlighting their main areas of application, and presents the study realized for identifying the level of knowledge, use and effective experimentation of augmented reality applications by mobile device users. The results of this study could be very useful to the socio-economic environment, starting with the field of research, continuing with developers and providers of augmented reality solutions, manufacturers and providers of hardware infrastructure support for augmented reality solutions and systems, final users of these solutions, both individuals and businesses, and experimenting digital communities.

Key words: augmented reality (AR), virtual reality (VR), mobile devices, mobile operating systems

JEL classification: C88, L86, M15

INTRODUCTION

Informational globalization and digital economy has brought important changes at individual level, as well as corporate level; the development of technologies and the amplification of access to them generated quick transformations at the level of human perception, developing new needs and individual capabilities for experimenting.

The last decade, through the globalization of the digital business environment has generated new individual habits regarding needs for consumption, accepted forms of presentation and purchasing of products in the digital environment, thus establishing a level of digital saturation which can already be integrated to the traditional category; exceeding this level was triggered and based especially on the extension of human capacity of perceiving the reality, helped by an adequate technological infrastructure. From this perspective, at global level, the 60s launched a new challenge opening a new way, that of augmented reality (AR), and incommensurable possibilities for using its applications in all the areas of socio-economic activity.

Since then, augmented reality had consolidated as technology, incorporating complex applications and systems in more and more fields of the global economy; the rapid evolution of mobile devices and the virtualization of the digital environment have prepared an auspicious environment for massive implementation of AR solutions at global level.

In this context, augmented reality, alongside virtual reality can offer very important support solutions in modeling the real world with the aim of extending the human capabilities of perception, allowing the opening of a new phase in the world's socio-economic development.

Starting from considerations related to evident tendencies that have manifested at global level in the development and implementation of AR technologies as support systems in all the fields of human and economic activity, the present study briefly presents the most important

aspects related to AR technologies, highlighting their main areas of application, and presents the research carried out with the aim of identifying the level of knowledge, experimentation and employment of AR applications by mobile device users.

Given the goals of this study, relevant aspects had been taken into account when choosing the population participating in the research, considering that experimenting AR solutions supposes the followings:

- the existence of an adequate hardware, software and communication infrastructure, based mainly on mobile devices and technologies - it was required to identify individuals having at disposal this kind of infrastructure;
- Use of digital environment as general platform - the population of the research had to consist of users of the digital environment, having consolidated ICT competencies, and used to downloading and installing desktop and mobile applications.

Other considerations taken into account in selecting the studied population were based on the fact that any software solution or application:

- regardless the platform or the field of activity for which it was developed, is launched and amply debated in the digital environment; digital communities of developers and of users are those who influence the trajectory of these applications; it is evident that knowledge of and experimentation of these AR solutions imply the same path; as a consequence, participants in the research had to be members of collaborative communities specific to the digital environment;
- is launched on a global market and for the use of a universalized diversity of potential or final consumers; as a result, participants in the research had to respect these proportions and come from all over the world, regardless the country of origin or residence.

The results of the present study are useful for the actors of the socio-economic environment, starting with the field of research, continuing with developers and providers of such solutions, manufacturers and providers of hardware support infrastructure for augmented reality solutions and systems, final users, either individuals or corporations, and experimenting digital communities.

LITERATURE REVIEW

1. About Augmented Reality

It is said that Augmented Reality has a history as long as the field of computer graphics; its beginnings were laid in 1956 by Morton Heilig, considered to be the father of virtual reality (VR) who started designing his first virtual multi-sensorial experiences (sensorama machine) [15].

Augmented reality, as term, was introduced only in 1992 and referred to overlaying computer-produced representations on top of the real world. Tom Caudell and David Mizell, brought into discussion the advantages of augmented reality in comparison to those of virtual reality seen from the perspective of lower needs for computational power and multimedia processing [21].

Augmented reality, in the specialized literature has got several definitions. It defines the timely integration of digital information with multimedia elements taken from the user's environment [11].

From another perspective, AR appears as real time display, visualization of several layers of information taken from the AR user's environment having diverse digital representation forms, from text to image and multimedia [12].

According to another definition, AR appears as a field of virtual reality (VR) in ample development, through which composite systems are generated combining scenes captured from the user's real environment with additional sets of digital, multimedia information generated by computer and overlaid, thus generating the augmented reality [18].

From the same perspective of including augmented reality into virtual reality, AR is defined as a variation of the VR concept; but the two concepts are differentiated; while VR comprises technologies that completely integrate the user in an artificial environment, disconnected from the real environment, in AR the user has access to the real world through overlaid multimedia interfaces

that are complementing it (Azuma, 1997). The same author points out that, though some authors associate AR with the use of HMD (head-mounted display) devices, it should not be reduced only to these aspects; according to the study carried out by the author, augmented reality is a system combining real environment with the virtual one using 3D recordings and having real time interactivity (Azuma, 1997).

Augmented reality is also defined as artificial environment through which the real environment is complemented in real time with virtual elements with the aim of improving innate human abilities; AR thus creates interactive systems that combine elements of the whole real environment and use diverse support devices for combining layers and types of processed information (mobile devices, head-mounted display, tracking system, visual display piece, desktop, projectors, etc.) [6].

New Media Consortium, in "The Horizon Report" published in 2011 refers to AR as a superior level of representation of the real world through superposing information over images using specific devices (computers, mobile terminals, multi- and hypermedia, etc.) providing the final users more intuitive access possibilities [16].

Taking into account the most important type under which augmented reality is known, several interpretations are indicated; depending on the implementation modality of AR two types are identified, namely: marker-based and marker less. Marker-based AR implementations are used by a starting image that triggers an action when read and recognized by a digital device (photo camera, mobile device, etc.); presently, it is the most used AR type. Marker less augmented reality is more complex, extending the capabilities of a digital device with location-based functionalities (for example GPS localization); for this reason in the specialized practice this type of augmented reality is also mentioned as location-based or position-based AR; this type is more difficult to develop because of the technological limitations of the infrastructure elements on which it is based and combines (i.e. accuracy of geo-locations on GPS devices, bandwidths, respectively connection and transfer speed of technical support for communication, etc.) [10].

(Rabbi and Ullah, 2013: p 33-34) identified a set of important challenges in the field of development of augmented reality, for example: performance of AR experiments, the closest alignment of these with the real world, mobility and portability of AR and achieving a visualization in these systems, so that differences in display of AR objects compared to real ones to be imperceptible for the user.

(Behrang Parhizkar et al., 2011) provide a classification of AR applications enforcing three important categories, namely desktop, mobile and web-based. In the web-based applications category specific applications from the field of education, medicine, marketing and game-industry are enumerated. In their study, the authors considered as parameters for comparing AR applications the following: quality, simplicity, availability and efficiency. In the field of education the following systems are identified as web-based applications: MARIE (multimedia augmented reality interface for e-learning), Scimorph (AR application for children) and LearnAR (AR application for e-learning). In case of medicine, AR systems for surgery, study of anatomy and medical training were identified.

2. Current fields of application of AR

Augmented reality applications have penetrated all the fields of activity having known an impressive development during the last decade, respectively an increment in types and numbers of employment modalities for which these applications are designed. The specialized literature has carried out a series of classifications of AR technologies, applications and emblems, including the fields of activities for which they have been designed. A study carried out by (Nur Intan Adhani and Dayang Rohaya Awang Rambli, 2012) includes among the most important fields of activity served by mobile AR applications the followings: sports, games, entertainment, medicine and health care, cultural heritage, education, marketing, media. The authors also made a ranking of AR devices used by these applications, resulting that the most used ones were the handheld devices, followed at great length by projectors and HMD (head-mounted display) devices.

Medicine

(Khawla Ben Abderrahim et al., 2013, p: 26-27) identified a list of AR systems used in medicine, including Vein viewer (Computerized image projection system of patient's veins using infrared light), CASPER (support system for carrying out punctures), Tedesys (3D imaging support system for surgery), CAMDASS (Computer Medical Diagnosis and Surgery System), Exakis (support system in physiotherapy**).**

Military sciences

(Le Roux Willem, 2010) presented a series of examples of possible AR applications as support for the most important commanding and control functions specific to a Joint Operation Centre; based on these functions the author referred some augmented reality applications as: sandbox with AR, visualization of specific information based on the positioning and geo-located orientation using AR specific devices, use of AR in simulating sequences of events, use of AR devices as support in training and exercises specific to special operations.

E-commerce

(Li Xiao-J et al., 2013, p:1135-1136), from the perspective of online sales, e-commerce and traditional bi-dimensional form of presentation of products identifies an online product display system using augmented reality technologies. The authors defined both compulsory and optional elements for the interface level of the proposed system; among compulsory elements at this level they also include the AR type interface; at service function level they also integrate augmented reality modules including both marker-based and marker less AR.

(Canavilhas João, 2013), starting from the generalization of using mobile devices, points out the importance of using augmented reality in the media industry and the new opportunities and forms of presentation and communication of information that AR can provide.

Education

(Specht Marcus et al., 2011) specified the fact that mobile AR systems may be applied in numerous educational fields; the authors integrate mobile AR applications in a matrix of educational models based on educational objectives and contextual information; starting from the educational objectives and identifying aspects linked to the implementation and context, the authors highlight among the dynamically usable AR elements 3D Objects, augmented books, Sensor-Based Layers.

(Kesim Mehmet and Ozarslan Yasin, 2012) explore modern technologies that may be used in the field of education, identifying new tendencies in the employment of augmented reality in this field; after highlighting technologies specific to AR systems, presenting pinch and data gloves, head-mounted and handheld displays, the authors point out that AR has a huge potential for being effectively used in learning, entertainment and edutainment, the most important advantages being linked to increasing users' perception and real time interaction with their surrounding environment.

Design and manufacturing

(Nee et al., 2012) identified systems in the field of design and manufacturing, the most important areas of AR research, also offering a classification of the main virtual reality and augmented reality systems used. Concerning AR systems, the authors list AR-based design systems including collaborative and distributed design systems and visualization-based AR systems, as well as AR systems used in robotics. AR applications in industry are also presented, starting with the Boeing project in the 90s and continuing with multiple applications in the automotive and aircraft construction industries, the authors also suggesting the ubiquity of AR solutions in industry.

AR games

(João Jacob et al., 2012), demonstrating the applicability of augmented reality in the game industry, presented a solution based on using OpenGL ES 1.1[i] and the Android SDK (software development kit)[ii] for developing a multiplayer type action game belonging to the location-based mobile AR category.

Social networks

(De Chiara et al.,2011), starting from the globalization of using social networks on mobile devices, made a prototype of a mobile AR system similar to social networks enriched with specific augmented reality technologies.

Tourism

Augmented reality applications relying on location-based services make possible an extension of the functionalities offered by mobile social networks and mobile applications for tourism; these allow, with the help of AR technologies, identifying some points of interest for the members of the social network regarding places for serving dinner in a geo-localized area based on maximum distances and user's coordinates (Farhat et al., 2013).

A considerable number of mobile AR applications have been developed for tourism, being evidently dependent on the operating systems of mobile devices used in AR technologies, and many of the applications, even those of geo-location; such perspectives on AR applications for tourism depending on location and mobile operating systems on which they operate, bring into the forefront the availability of a great number of applications for iOS (Tuscany+, Basel AR Tourist Guide (also available for Android, Symbian and BlackBerry OS), Street Museum London (also available for Android OS)) (Kounavis et al., 2012).

Agriculture

One of the AR applications for agriculture may be described as a guidance system for large agricultural equipment (e.g. tractor) and can be regarded as a complex system of hardware, software and AR technologies; it uses specific data collected by sensors that, after being processed, are offered as viewable results in 3D format on AR (*eye monitor glasses)* (Santana-Fernández et al., 2010).

3. Augmented reality – statistical overview

A visualization of the evolution of interest manifested in the online environment for augmented reality (AR), performed using Google trends indicates, at global level, for the period starting with 2004 up to present, a significant increase marked especially on the temporal segment September 2008 – October 2009; in April 2012 the interest manifested for AR was at its maximum, after that until now there has been a decreasing tendency of the manifested interest.

According to the same analysis, the most used terms in searches connected to augmented reality are: AR iPhone, AR android, AR apps, Google glasses, AR mobile, AR game; these searches are initiated by Internet users from USE, Canada, Western Europe, India, Indonesia, Australia. Taking into account the number of accesses on this subject, most of the users come from the following cities: Singapore, Bangalore, Munich, Los Angeles, New York, Toronto, London, Amsterdam, Jakarta, Sydney.

At the level of year 2011, according to researches carried out, a very low percentage of only 0.1% of AR technology users was reported, but it is estimated that an increased percentage of 1% of the population to become users of these applications by 2016, applications which will register an exponential increase on the specialized market [14]. According to the same source, the AR applications' market will have an increase of revenues from $181.25 million in 2011 to $5,155.92 million in 2016. The most important providers of AR solutions were determined as: Total Immersion (France), Metaio (Germany), Wikitude (Austria), Zugara (USA), and Layar (The Netherlands).

Juniper Research, in its report points out that by 2017 more than 2.5 billion mobile AR applications will be downloaded yearly to smartphones and tablets [13].

From the perspective of the aim of use, online researches indicate that 19% of users use augmented reality as an alternative for written literature, 16% use AR applications at conferences, the same percentage of users use AR in online publicity campaigns, while 8% uses these solutions for improving sales of own products [8].

Romania has not been left outside the new trends in augmented reality; in 2012 the company ARworks, developer of smartphone and tablet applications, provided a free AR application for

mobile devices using Android and iOS operating systems, allowing to make video clips with AR technologies [17].

At global level, it is estimated that by 2015 AR technologies will generate a revenue surpassing 1.5billion dollars. At the same scale, the number of smartphones that support AR technologies is in continuous increase, at present representing over 40% of the held mobile phones. In Romania, there are approximately 2.5–2.6 million actively used intelligent terminals allowing AR applications [20].

RESEARCH METHODOLOGY

a. **Problem formulation**

Starting from the very large and varied palette of AR applications and the fields where these are used, and considering these solutions as generators of a very rich offer on a growing market, it is very useful to identify the level of demand for these products, considered both from individual and business perspective.

From this perspective, the present research, limited only to the individual aspect of the demand for AR applications, identified, on one hand, the level of knowledge related to augmented reality and existing applications, on the other hand, the types of users of these solutions.

b. **Choosing the sources of information**

This type of study required using a set of information sources formed by primary information resulting from a questionnaire-based survey and secondary information resulting from statistical data and from offline and online documentary research.

c. Defining the Sampling Frame

From the perspective of identifying the potential demand for AR products, the research was aimed to individual users, physical persons, owners of mobile devices with mobile Internet connection, which was imposed as minimal hardware and communication infrastructure requirement for experimenting and using these products.

d. Data Collection

The questionnaire was developed in web-format, respectively mobile-based; in carrying out the study we used the potential of web and mobile social networks from another perspective, that of extremely useful and much used research tool. Given the topic of the study, for facilitating access to the web location hosting the questionnaire, QR (quick-response) codes was generated and used.

e. Elaborating the questionnaire

Taking into account aspects related to globalization of social networks, the topic of this study and the fact that the use of mobile devices and of specific applications suppose a higher level of education and ICT competencies, the necessity of placing the questionnaire in several linguistic versions was established; this decision aimed acquiring a more diverse structure in nationalities present on the social networks.

The questionnaire was conceived in a modular structure consisting of 14 questions, articulated as follows:

- The first module referred to data about the respondents - age, gender, education, country of origin and of residence, the environment they live in (urban, rural) and their field of activity;
- The second module comprised questions regarding the use of mobile devices (mobile phone, smartphone, tablet, laptop, iPad, e-book reader) and of mobile Internet connection, respectively identification of operating systems used on these mobile devices;
- The third module had the aim to identify the users' levels of knowledge regarding augmented and virtual reality, respectively the temporal horizon of acquiring this knowledge;
- The last module identified the types of AR applications experimented or used and the frequency of deploying these activities.

f. The Sample

Based on the aims of the research, users of mobile devices were targeted, who were present on web and mobile social networks and who completed the questionnaire.

It has to be mentioned that, in order the carry out the sampling, it was necessary to consult statistical data regarding the profile of mobile device users, on one hand, and the web and mobile social networks and the profile of their users, on the other hand.

In this context, statistics referring to the most used web and mobile social networks, i.e. Facebook, Twitter, Google+, LinkedIn, point out that the first places in the ranking of the user countries were held by: USA, India, Brazil, Indonesia, Mexico [19]. According to the same source, Romania is situated only on the 56th place in the world. Regarding the gender repartition of Romanian users, the same source indicates an equal proportion of women and men present on social networks on the web. Taking into account the repartition by age groups of Romanian users the biggest category is that of users aged 25–36, followed by users aged 18–24.

Regarding the users of mobile social networks, statistical studies indicate a user profile characterized by the following: the most active are women aged 18-29(67%), having a college degree and an income above average [9].

g. Methods used

As it was specified previously, social networks like Facebook, LinkedIn, Google+ and Twitter were used with the aim of presenting and launching the research, and for contacting potential respondents to the survey. A special topic was created on each of the four social networks in order to carry out the research; information on the way the study would be conducted, the invitation to participate in the survey, respectively the request to recommend the survey to their own network of friends were placed on them.

It has to be mentioned that, as a result of the study, we noticed the huge potential of these social networks, that can be considered globalised collaborative tools, in supporting the implementation of this type of studies; using this tool during the entire period of the research resulted in 1178 subscribers to the topic of the research, that also constituted the researched population, involved integrally in the survey. When closing down the survey period, 827 questionnaires were completed from which 801 were retained as valid. In our opinion an extremely important aspect should be mentioned in relation to the response rate (70.20%), that may be considered a very high one and its value cam be explained by the fact that, within the social networks the most important part of subscribers became also respondent.

RESEARCH RESULTS

The analysis of data resulted from the questions of the questionnaire's **first module** allows *the socio-demographic identification of the subjects*. Results indicate a very close proportion of women (49.61%) and men (50.39%) in the structure of respondents. Regarding *the age categories respondents belong to*, at the extremes we have the category of those aged 35-44 as the best represented category (28.13%) and the category of those aged over 65 with the lowest representation (3.12%); we must also remark the close percentage of age categories 18-24 (18.93%) and 45-54 (19.98%).

The respondents' education level puts at the top the category of university studies (39.12%), followed by college graduates (28.17%), while basic studies have a very poor representation (6.67%).

It has to be mentioned the obvious relationship between the best represented age categories and the respondents' level of education.

Respondents having the origins in Romania (76.12%) and those who are residents in our country (59.62%) represent the majority of respondents. The respondents coming from other countries, with a percentage of 23.88%,have the following structure: Italy (12.34%), France (12.11%) and Spain (11.92) are the best represented countries; at the other end having placed Finland (0.56%); with percentages between 5-10% there are, in decreasing order of their

representation, countries like USA, Germany, Greece, Rep. Moldavia, Great Britain. The segment of residents in other countries than Romania is also well represented (40.38%), evidently including non-residents born in Romania and in other countries (figure no. 1).

Regarding *the environment in which respondents live*, we have an overwhelming majority of respondents from urban environment (90.56%). It should be noted the fact that all those who indicated Romanian residence fit into this category; this aspect may indicate the fact that in our country online and mobile communication media, even if we consider only communication networks, it is not sufficiently used in rural environment, while in other countries this barrier does not exist.

This aspect can be explained in Romania by the lack of adequate infrastructure, on one hand, while, on the other hand, through the insufficiency of instruction and lower level of ICT competencies of Romanians residing in rural environment.

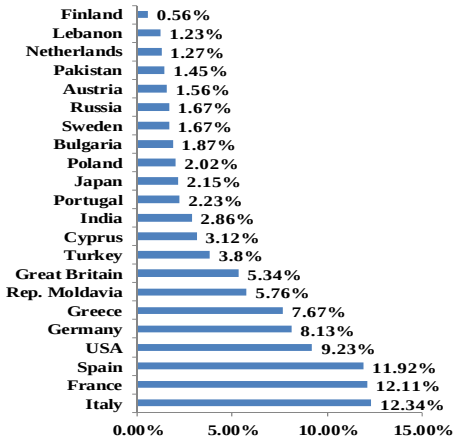

Figure 1. The structure of the population according to their country of origin

The fields of occupation indicated by the respondents put at the top of the ranking, with more than 8%, the following fields: sales, commercial activities (15.23%), production, manufacturing, engineering, construction (14.23%), ICT, development (8.98%), environmental services (8.38%), tourism, services, entertainment (8.56%) and business services, real estate (8.34%).

In case of *Romanian resident respondents*, the fields of occupation are structured in a different way in comparison to the entire population of the research; thus, the main fields represented in this case (with percentages over 8%) are: business services, real estate (17.34%), ICT, development (12.76%), sales, commercial activities (12.11%), education (11.67%), production, manufacturing, engineering, construction (11.32%), student (10.34%), research, academic (8.12%).

For the questions of **the second module** the analysis of data resulted from the survey *identified the types of devices and the operating systems used by the respondents, respectively the availability of a mobile Internet connection*. It must be mentioned that we took into account the use of mobile devices and not their possession by the respondents, based on the fact that many professionals get these devices for business purposes from their employers and, as a consequence, they do not purchase another device, as a duplicate. Another aspect that should be highlighted is that related to the differentiation in the list of mobile devices of mobile phones from smartphones; this differentiation was made due to the configuration characteristics required for installing and using AR applications, requiring a specific configuration available mainly in case of smartphones.

A surprising aspect is represented by the existence of a small percentage of respondents who do not use mobile phones (0.76%), while the rest of 98.24% use one. Based on the percentage of using one from the listed mobile devices, except for mobile phones, the most used are: laptop (69.89%) and smartphone (65.23%), while the less used (below 30%) are: iPad, tablet and e-book reader.

In case of *Romanian residents*, a different structure is observable in the use of mobile devices in comparison to the whole population of the study. The first aspect to be highlight is related

to the percentage of mobile phone users, that is 100%; then, though all the categories, except for e-book readers (16.20%) obtained higher percentages than those of the entire population, the ranking of the mobile devices used is the same; thus, laptop (79.20%) and smartphone (68.59%) remain on the first places, followed by iPad (32.34%) and tablet (26.12%); moreover, for this segment of respondents a singular tendency is revealed, namely that an important percentage (38.57%) points out the use of all the indicated mobile devices, while only 32.12% uses all the devices from the list, except iPad and e-book reader.

The identification of *the operating systems used on the mobile devices* reveals iOS as the most used operating system (38.12%), followed by Android(23.34%), BlackBerry (13.12%) and Windows phone (10.11%), while other operating systems (as JavaMe, Bada, Kindle, etc.), except those indicated in the list, are used by 3.65% of the respondents.

Again, the results for *the Romanian residents' segment* are different from that of the studied population. Android OS (45.23%) leads the ranking, followed by BlackBerry OS (18.15%) and iOS (18.12%) in almost equal proportions, followed by Windows phone (10.11%); the rest having percentages lower than 5%.

Global statistics indicate at the top of the most used operating systems for mobile devices: Android, iOS, Series 40, Symbian and, according to the same statistics, Romania respects the same tendencies [7] ; but the results of the analysis for this topic highlight a slightly different situation at the level of the population, as well as at the level of Romanian residents, in comparison to global statistics.

Data analysis regarding *mobile Internet connection* at the level of the entire studied population indicates a percentage of 85.12% of the respondents having this type of connection, while in the Romanian segment this percentage is 68.12%.

For the **third module** of the questionnaire, that is, together with the last module, the most relevant for the present research, analysis of the data offers important information on the respondents' level of knowledge regarding augmented reality, virtual reality and the length in time of acquiring this knowledge.

A specification has to be made concerning the launch of the two questions related both to virtual reality and augmented reality. Starting from the fact that virtualization is a concept that has already become common in the daily language, we aimed to identify the actual level of knowledge related to the two concepts, as well as the correct differentiation between the concepts, so that to further corroborate these knowledge with the effective use of AR applications.

The respondents' *level of knowledge about AR and VR reflected in comparison* indicates a significantly higher percentage for low level knowledge on AR (55.76%) in comparison to VR (38.54%). In case of very high level of knowledge, the percentages have the same tendency, though in both cases are very low. For these two items we must note an important aspect, namely that this tendencies manifest both at the level of the entire studied population, and that of Romanian residents' segment, for which some particularities were previously identified (table no. 1).

Table 1 - Comparative level of knowledge on AR and VR

Level of knowledge	AR	VR
Very High	1.12%	2.23%
High	11.56%	10.45%
Medium	19.56%	36.78%
Low	12.00%	12.00%
Very Low	55.76%	38.54%

Indicating *the temporal level of acquiring knowledge* related to augmented reality, brings to forefront an important percentage (35.13%) of respondents who do not know anything about this subject, while the percentage of those who have knowledge about AR for more than three years is only 10.23%; the segment of those who have recently acquired knowledge on AR (less than a year) is the highest (32.52%).

The last module had the aim of *identifying the level of experimentation or of use of the main types of AR applications and the frequency of their employment*. The results of data analysis highlight among the most used categories AR games, entertainment (26.12%), followed by location-based services (23.34%), AR browser (Layar, Junaio, Wikitude, etc.) (22.12%); among the less used, with percentages below 5%, we find medical, health systems, AR-books, advertising, media and other solutions (figure no. 2). Analysis of data regarding the frequency of using augmented reality applications highlight two classes of respondents, diametrically opposed as action, namely: non-users of AR, the most important segment (32.78%), who have never heard of these applications, and the experimenting users, even passionate (18.23%) who try out any new AR application.

With close percentages, two intermediate categories of users can be identified, those who know about AR applications but they have never tried them, passive users (24.87%) and those who tried out the AR solutions once, curious users (24.12%).

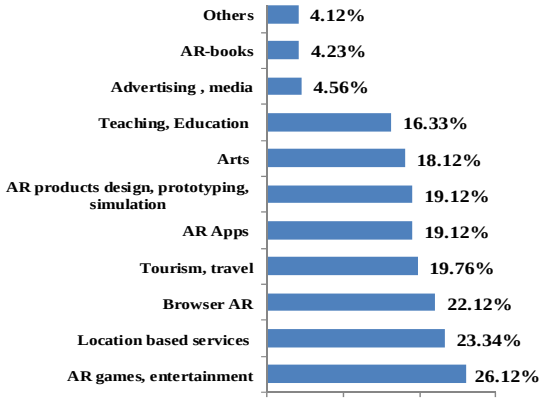

Figure 2. AR applications used

CONCLUSIONS

The study has initiated a topic for further reflection on the level of knowledge, actual experimentation and use of augmented reality applications at the level of a population well familiarized with the digital environment and its globalised forms of communication, as well as with using mobile hardware and software infrastructure.

The results obtained from the analysis of survey data allow the identification of a profile of the potential or actual user of augmented reality applications; the general profile specific to the studied population identifies the user as being a male age 35 – 44 with a university degree, who lives in urban environment, works the fields of sales, commercial activities or production, manufacturing, engineering, construction, uses a laptop and a smartphone, respectively a mobile Internet connection; for the mobile devices uses as operating system iOS and Android; has a very low level of knowledge related to augmented reality, doesn't know anything about these technologies and has never experimented them or used them. In case of Romanian residents, the changes in this profile concern the fields of activity: business services, real estate or ICT, development.

For the research environment and the AR solution developers, the results of this study reveal a contradictory aspect, namely: though the specialized literature offers a series of very comprehensive studies attesting the level of knowledge and use of these technologies, the level of individual awareness in the globalised environment of the Internet is extremely low; from this perspective an increased publicity would be very useful, augmented and carried out with AR tools, applications and technologies using the most important globalized communication medium, the digital one. The existence of an already high number of AR applications and systems serving diverse fields of activity, but that are not known, experimented and used, demonstrate a very weak dissemination at global level of the information related to this topic.

AR solutions developers and providers, using the results of the study can identify an important market segment completely unaware about the existence and utility of these solutions and that could be transformed in a potential or actual user segment of AR solutions if they choose to develop promotion strategies in the digital environment, using web and mobile social networks for disseminating information and AR applications.

Manufacturers and providers of hardware infrastructure support for augmented reality solutions and systems can identify, from the results of the research, new opportunities; on one hand, they can elaborate development strategies of new products, adapted to augmented reality technologies and applications, on the other hand, identify an important segment of individual and corporate demand for infrastructure products required for using AR.

From the results of the research, experimenting digital communities can identify and attract new members, thus generating an implicit increase of the experimenting or actual users' segment of augmented reality solutions, playing a promotional role for these technologies at global level.

Not in the least, participants in this research were initiated in a field, mainly unknown and non-experimented by them. Using the digital environment and mobile and web social networks, a new horizon towards experimenting new technologies and identifying new forms and fields for using them was opened to them.

It becomes evident also in this case, that good information on and knowledge of new technologies and their use in a variety of fields of activities, respectively substantiation of the decision on experimenting, adopting and using them represent important advantages in the global socio-economic development.

The present study can be considered as unique in the landscape of augmented reality, opening new perspectives of interdisciplinary research, given the vastness of areas for using augmented reality technologies and applications and their present stage of knowledge, experimentation and employment.

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[i] *cross-platform API for full-function 2D and 3D graphics on embedded systems - including consoles, phones, appliances and vehicles, source: http://www.khronos.org/opengles/, accessed on January 2013*

[ii] *a set of development tools used to develop applications for Android platform, source: http://www.techopedia.com/definition/4220/android-sdk, accessed on January 2013*

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