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AUGMENTED REALITY IN UNIVERSITY CAMPUS INTERACTIVE ORIENTATION

Claudiu-Ioan MUREȘAN, Anton-Marius POPA, Radu COMES

***Abstract:** This paper proposes the use of a mobile device application that makes use of virtual reality and augmented reality elements to provide information in regards to each building within the campus. Nowadays mobile devices have become complex devices that can be used to make our everyday life better by installing and using applications that greatly extend their utility. The case study of this application has been done at the Technical University of Cluj-Napoca for the Faculty of Machine Building and the Faculty of Mechanics, since there are many freshmen students or other people that are not familiar with the University layout and they are having a hard time navigating through the complex structure in order to reach the desired classroom or laboratory.*

***Key words:** virtual reality, augmented reality, campus navigation, building, mobile application.*

1. INTRODUCTION

Traditionally, building orientation is done using signposts and arrows to offer guidance. However, these methods cannot offer a precise information in regards to a certain class room or laboratory within a vast complex university campus. Especially new students or people who enter this areas for the first time are having a hard time to orientate themselves even with the support of the signposts and arrows located on the walls [1].

There are many campus universities that have static maps located at the entrances, either they are printed and posted on the wall or they are available digitally on interactive touch screens. The main problem with this system is that as soon as the person starts walking towards the desired location, the directions that they had at the entrance is not available anymore. Most people will use their smartphone to take a photo of the static map in order to have access to this information on demand while they are navigating through the campus. But having a 2D map does not solve complex campus structures with multiple floors and underground walkways.

Within the Technical University of Cluj-Napoca at the Faculty of Machine Building and Faculty of Mechanics there are no static maps or interactive touch screen displays with the building layout and its complex structure.

Therefore, it is necessary to create an interactive solution that takes into account the present trends, in order to be easy to interpret and as enjoyable as possible. Since today almost everyone has a smartphone, it represents a viable solution to create an application for smartphones to enhance the orientation within the University campus. But in order to create a good application that will assist freshman students it is important to extend the research and to obtain feedback directly from them regarding their orientation and navigation within the campus.

The first step of this research is the launch of a marketing study, as it is necessary to obtain information from the subjects so that we can see whether it is necessary to implement a digital 3D map of the university campus.

The second step is to create a map that is easy to interpret and navigate.

In the third step, multiple photos will be taken to create the virtual reality tour that will

highlight each corridor, underground passway and all the campus rooms.

The final step represents the creation of the mobile device application that makes use of the map created at the second step and enables virtual reality and augmented reality elements on top of it using a smartphone.

2. GENERALITIES OF MARKETING RESEARCH

The purpose of the marketing research is to interview a sample of subjects in order to identify the information and needs of the subjects. This research helps us clarify what the subjects needs in regards to the campus navigation [2].

It is very important for the marketing research to take into account the subject needs with ease so that we do not put the interviewee in difficulty. If the questionnaire contains more difficult questions, the subject gets bored, is no longer interested in it and therefore quits the questionnaire.

The marketing research is validated only when most of the assumptions underlying the research are invalid, because only then can we say that the results of the evaluation are solid [3].

The marketing research in this paper was aimed at interviewing subjects from the first year since they are freshmen and they are not familiar with the faculties layout. They can provide valid information about the problems regarding finding a certain classroom or a laboratory.

3. SIMILAR NAVIGATION SYSTEMS

There are multiple Universities from all around the world who have implemented similar applications in order to make the life easier for freshman students or other people who are visiting their campus.

Some of these applications have started as thesis done at different study cycle (either bachelor studies, master`s studies or even PhD).

The bachelor thesis done by Benjamin Lautenschläger named *Design and Implementation of a Campus Navigation Application with Augmented Reality for*

Smartphones represents one of the first navigation systems that makes use of a mobile phone. The application has been done in 2012 and it has been implemented at the University of Calgary. Since then mobile devices have evolved and their current processing power enables mixed applications that make use of virtual reality and augmented reality to be developed in order to enhance the orientation/navigation process within a complex campus structure [4].

Other researches have created applications that use a combination of GPS and augmented reality interface in order to navigate through a university campus [5].

The main draw back is that inside the building the GPS system does not provide accurate information and it cannot be implemented in large campus with multiple floors or underground walkways.

Therefore in this paper the authors purpose a mobile device application that makes use of virtual reality and augmented reality elements to provide a full interactive navigation system within the campus.

4. PROPOSED MARKETING RESEARCH AND THE NAVIGATION SYSTEM

In order to carry out the marketing research we used the Google platform through which the questionnaire was introduced and distributed online. The result of the research was processed using the SPSS software.

The virtual reality elements are represented by 360-degree photos done within the campus that can offer a better exploration due to multiple-angle viewing of the virtual environment [6].

In this virtual reality tour, photographs of the halls and of each area of the building were made. The user can explore all the areas using their mobile phone or even their laptop to familiarize themselves with all the classrooms, laboratories and amphitheatres that are present within the university campus.

The virtual tour was created with the help of several software solutions and a smart phone. Panoramic or 360 degree photos have been taken using the Cardboard Camera application. After making all the panoramic photos they

were processed using the KolorPanotour software in order to create the virtual tour elements. This software offers many features that can help among others with the creation of a tour with location, the sketching of a floor or even inserting a video file.

The mobile augmented reality application was made using the following software solutions: SketchUp for 3D modeling, and Unity with the Vuforia plugin for the augmented reality elements.

With the SketchUp program, the 3D model has been created and with the help of the Google Earth platform, the 3D models of each building of the campus was extracted and moved towards the interactive application.

Vuforia is an augmented reality software development kit for mobile devices that enables the creation of augmented reality applications. Vuforia system has been used to track images of the real environment within the campus in order to identify and highlight its location within the campus.

Using the Unity software, the mobile application for augmented reality has been built. In this software all the prebuild elements have been inserted such as each 3D model of each individual building, the photographs of each door and hallway and the 360 degree images that display the real environment [7].

When the application is started the user has the possibility to explore the 3D environment of the campus or use the tracking system that makes use of the smart phone camera to highlight his location. The user is required to orientate the camera towards a door number/name tag and the application will identify and display his current location within the 3D model of the campus layout.

For the creation of the virtual tour 114 panoramic photos were taken, in groups of 47, the grouping was done by floors of building and courtyard. To advance from one photograph to another and to go through the faculty's halls 61 links have been created between them.

The augmented reality application was designed for the operating system that have at least Android 4.0 because the tracking system used by the application requires this as a minimum requirement in order to be able to use the identify and compare photos taken by the live stream of the camera in order to accurately identify the current location of a specific room within the university layout [8].

Also a 2D printed version of the university campus has been done, this can also be used by the augmented reality application in order to display the 3D model of the campus as it is shown in the figure below.

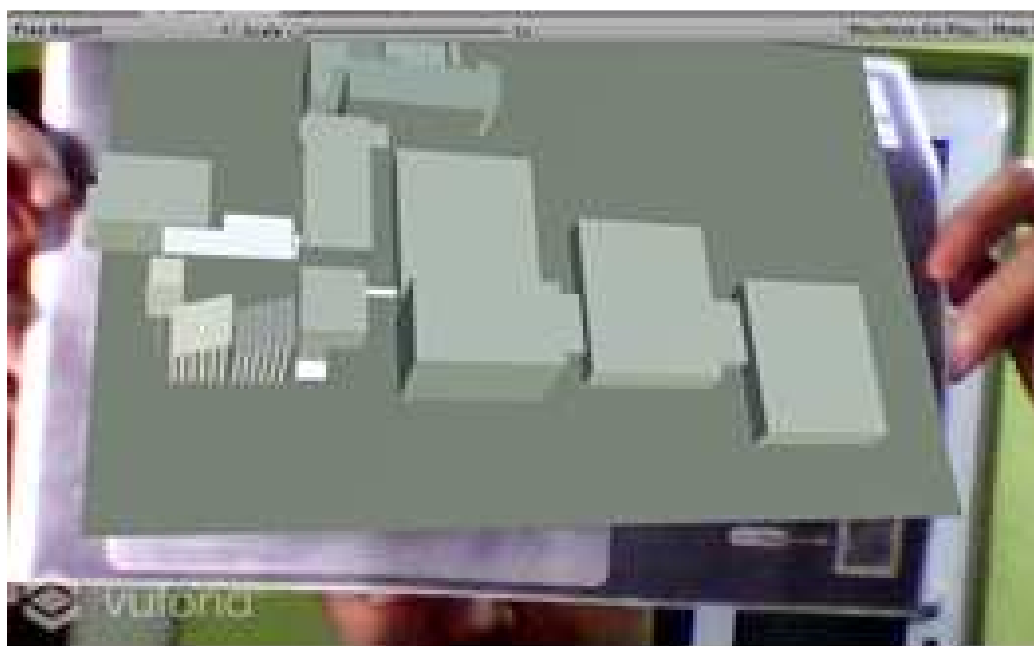


Fig.1. The 3D model of the campus layout

The 2D printed version (printed on a A2 paper) has been positioned at the entrance to the A building given the fact that the main entrance is also there.

The map contains all 8 buildings. It is created in such a way that the floors are overlapped and the numbering of the classrooms and laboratories was done within each floor of each building.

The 2D printed map has also two QR links that present the user a tutorial in regards to the

use of the interactive navigation system proposed by the authors of this paper. Individual links are created for the virtual reality tour (interactive 360 degree photos) and for the augmented reality system that can highlight their current position within the campus directly on the 3D model.

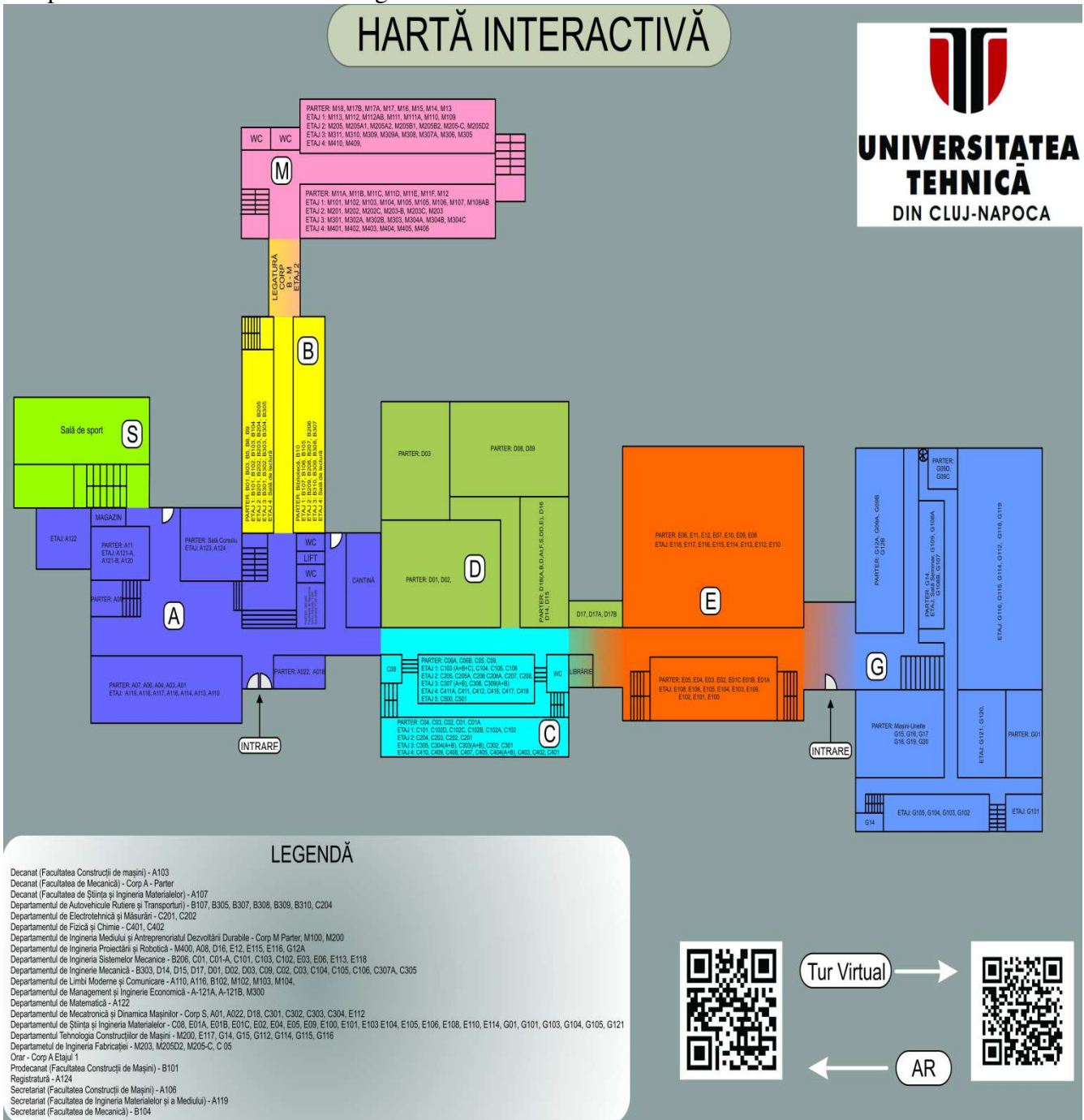


Fig.2. The 2D printed map

5. MARKETING RESEARCH RESULTS

For the marketing research 47 subjects were interviewed. The questionnaire had a content of 14 questions out of which 4 were for identification purposes.

The most important questions are listed below:

Question 1: Have you encountered difficulties in finding a classroom?

Table 1.

Question 1	
Yes	No
39.30%	61.70%

Question 2: Where do you get information regarding finding a specific classroom?

Table 2.

Question 2		
Colleagues	Professors	Other
68.09%	2.13%	29.79%

Question 3: How difficult was finding the classroom or the laboratory you wanted?

Table 3.

Question 3				
Very easy	Easy	Medium	Difficult	Very difficult
19.15%	25.53%	36.17%	17.02%	2.13%

Question 4: How do you rate the navigation application in regards to its usefulness?

Table 4.

Question 4				
Very good	Good	Medium	Weak	Very weak
53.19%	23.40%	14.89%	4.26%	4.26%

Question 5: What is your opinion regarding the campus navigation application?

Table 5.

Question 5				
Very good	Good	Medium	Weak	Very weak
59.57%	21.28%	14.89%	0%	4.26%

As we can see in the answers to the questionnaire there are some difficulties in

finding a classroom or a laboratory; most students are informed about the location of a classroom or a laboratory from colleagues. The idea of using an interactive navigation system based on AR and VR is desirable over 50% of the students interviewed.

6. CONCLUSIONS

Marketing research was the basis for the continuation of this research by interviewing the subjects and interpreting their results, which led to the creation of the paper.

Each of the subjects probably had a problem finding a classroom or a lab, but with an interactive map the number of those who encounter problems will be reduced consistently.

The virtual tour helps freshmen students and other people to orientate and navigate through all the buildings of the University campus with ease. Using the virtual reality elements of the application the users can take the tour from their homes so that they know exactly where they want to go and what is the correct route.

7. REFERENCES

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REALITATE AUGMENTATĂ ÎN ORIENTAREA INTERACTIVĂ ÎN CAMPUSUL UNIVERSITAR

Rezumat: Această lucrare propune utilizarea unei aplicații pentru dispozitivele mobile care utilizează elemente de realitate virtuală și realitate augmentată pentru a furniza informații cu privire la fiecare clădire din cadrul campusului. În prezent, dispozitivele mobile au devenit echipamente complexe care pot fi folosite pentru a face viața de zi cu zi mai bună prin simpla instalare și utilizare a unei aplicații care extinde foarte mult funcționalitatea acestora. Studiul de caz al acestei aplicații a fost efectuat la Universitatea Tehnică din Cluj-Napoca pentru Facultatea de Construcții de Mașini și Facultatea de Mecanică, deoarece există mulți studenți noi sau alte persoane din afara facultății care nu sunt familiarizate cu structura facultății și care întâmpină dificultăți de navigare prin structura complexă a facultății pentru a ajunge la sala sau laboratorul dorit.

Claudiu-Ioan MURESAN, Technical University of Cluj-Napoca, Department of Design Engineering and Robotics, mclaudiu01@gmail.com

Anton-Marius POPA, Technical University of Cluj-Napoca, Department of Design Engineering and Robotics, anton.popa@muri.utcluj.ro

Radu COMES, Technical University of Cluj-Napoca, Department of Design Engineering and Robotics, radu.comes@muri.utcluj.ro