The integration of augmented reality in everyday life

Petrică Bota, Robert Săndică, Dana Simian

Abstract

Ever since their invention computers were designed to improve the user's performance and aid them in solving diverse tasks. Since the launch of the smartphone computers occupy a larger role in our lives and have become an extension of the user. The available interfaces that connect users to the computers and the Internet are slow in comparison to the processing power of the available computers and can be improved upon. The forms of input are limited to writing, pushing buttons, clicking or touchscreen. The goal of this article is to propose a new solution to the issues of data input and output. Our solution is to provide real-time augmented reality elements through the use of devices such as smartphones or augmented reality glasses. The purpose of these devices is to receive data without the user having to input it manually and offering information and assistance through the representation of 3D elements. As proof of concept we have implemented an Android app that helps the user reach his desired destination by using overlapping virtual cues on top of the camera's video stream. We have found that it is much easier to navigate with the help of the virtual signs due to the fact they provide clear, concise and difficult to misunderstand information. Though, we have developed this app as a proof of concept we consider that augmented reality can be implemented, in one form or another, into multiple fields such as: medicine, teaching, military, etc.

1 Augmented reality. Introduction

Processing power has drastically increased since the invention of computers but the way in which we interact with a computer hasn't changed much in the past decades. We consider that the main issue in working with computers is not the processing power of the computer but the speed with which we introduce and retrieve information. For instance, the IBM 7030 ("Stretch") released in 1961was able to perform 1.200 MIPS (millions of instructions per second) [1] at 3.30 MHz while more recently the AMD Ryzen 7 1800X released in 2017 is able to perform 304,510 MIPS at 3.6 GHz [2]. We can observe that the performance upgrade in processing power over the last 50 years is in the order of thousands of millions. Meanwhile, the average rate of introducing data with the use of a keyboard is around 50 wpm (words per minute). There are also exceptional individuals, such as Stella Pajunas or Barbara Blackburn, who can exceed 200 wpm[3]. The processing power of a computer is much faster than a person's ability to input or interpret data. For inputting data we are limited to

pushing buttons, touching screens, moving a mouse or a controller. For interpreting data we are limited by the size of our screens, our ability to interpret sounds and the speed of our reading.

The issue of user input/interpreting speed could be resolved either by implementing a neural net headset [4] or by adding an additional layer of virtual information on top of the real world. A neural net headset is a device that in theory can directly transmit the user's brainwaves to a computer. Elon Musk is one of the supporters of the neural net headset concept, especially since he started the company "Neuralink"[5] with the purpose of developing viable devices for direct human-computer communication.   Another way to solve the issue of data inputting and data interpreting can be augmented reality (AR). With the help of AR we can add another layer of information between our eyes and the real world. The additional layer of information can be used for data input and output

The goal of this paper is to study how AR applications can be used in order to improve the speed of data communication between humans and computers.

The main reasons we chose to focus on the implementation of augmented reality and not on a neural net headset are:

- The technology required to interpret brain signals is still being developed;
- A neural net head set would probably be considered a rather invasive device;
- The technology required for viable augmented reality exists and it is already being implemented by multiple companies such as Oculus, Vive, Microsoft;
- Any modern smartphone is capable of augmented reality features;
- A wearable such as AR (augmented reality) glasses is far less invasive than a wearable that is directly connected to your brain impulses; therefore the social taboo shouldn't be as relevant as in the case of the neural net.

An AR app works by projecting virtual information on a virtual layer that is displayed between the user's eyes and real life objects. In that virtual layer it is possible to display additional information regarding real life objects or interactions. Augmented reality has gained popularity over the past years but the technology itself is several decades old. The first AR system that provided and immersive experience by combining real life objects and virtually generated ones was developed in 1992 at the U.S. Air Force's Armstrong Labs in 1992 [6]. The device projects additional information on the pilot's helmet such as longitude, latitude or automatically colors enemy targets.

Augmented reality has reached millions of people through the smartphone. The smartphone is a device that is able to record and display information simultaneously; that makes it is perfect for the use of AR apps. Also, it is much cheaper than the devices used by the military.

An example of AR app is Pokemon Go. This AR app was released in 2016. It is the most popular AR app with more than 60 million active user as of 2017 [7]. The huge number of people who already use AR apps prove that users are interested in this technology.

At the moment, the most common devices that can be used to run AR apps are smartphones and AR glasses such as Google Glass [8] or HoloLens [9].
There are two main types of AR apps:

a) Apps that use marker points as reference for adding the virtual information;
b) Apps that don't require markers points in order to add data.

Marker based AR apps requires that you pre-program elements that will be recognized by the app which will then respond accordingly, either by displaying additional information or starting another process. For example, we could have a 2D picture of a pyramid that is recognized by the app which then adds a 3D pyramid model on top of the 2D image. It is much easier to program a marker

based AR app due to the fact that you simply program how the app should respond when it encounters a scenario for which it was prepared.

The second type of AR app does not required markers in order to function. This type of AR app should be able to identify patterns, colors or some other features that may exist in a camera frame and react accordingly, without being explicitly programmed for each specific scenario.

The main aim of this article is to study how AR apps could be used to improve the transmission of information to users. For this purpose we realized a comparison between the two types of AR apps. To highlight the advantages and disadvantages of marker based and markerless AR apps we developed an app of each type. We consider that this constructive method is able to cover all aspects related to our goal: app design, technologies available, evaluation of results.

The first app that we developed in order to study the AR technology was Virtual Reader[10]. Virtual Reader is a marker based AR app that provides additional information to the user by adding 3D elements on top of a predetermined 2D image. The next app we developed was a markerless AR app named Virtual Pathfinder[11]. The purpose of this app is to provide additional information that aids user to get from his current location to another one that he selected. This was done by adding a virtual path on top of a smartphone's video feed.

The rest of the article is organized as follows. In Section 2 we present the two apps that we developed and their capabilities. This section contains our original results. Section 3 presents the conclusions of this article. It shows how our apps relates to the initial goal of this article.

2 AR apps

Both apps we developed require specific devices and technologies. We took into consideration the most affordable devices for users. Smartphones are the baseline for the development of our AR apps. Smartphones are wide-spread. A report done by Wireless Smartphone Strategies (WSS) services [12] that encompassed 88 countries reveals the fact that more than 44% of people in developed countries own one smartphone. Moreover, most smartphones are capable of running virtual reality applications.

The implementation process includes apps development and markers design. We chose Unity as a software development environment both for Virtual Reader and Virtual Pathfinder. Unity is compatible with AR technologies and software development and has open marketplaces with lots of free or paid assets [13]. Moreover it contains great built-in physics mechanics that are easy to edit and work with.

For encrypting and decrypting the markers into and from different images we chose Vuforia. Vuforia is compatible with the Unity framework and allows us to create our own markers with the images that we desired. We only used the 2D features that Vuforia offers for AR development but other features like recognizing complex 3D objects or simultaneously recognizing multiple 2D planes of a simple 3D object, such as a cube, are also offered by Vuforia.

2.1 Virtual Reader

We started our research by creating a relatively simple AR app that provides additional information while reading. This information was represented under the form of 3D objects overlapping the 2D predetermined design (Fig. 1).

As mentioned previously a marked based AR app uses certain points as reference in order to "remember" how to react and what information to convey as a response. We used 2D images into which we incorporated these markers that the app uses in order to recognize the image and display the appropriate 3D object. In order to use the app you have to point you smartphone camera at the image that had the marker incorporated. Once the app recognizes the marker it displays the appropriate 3D object.
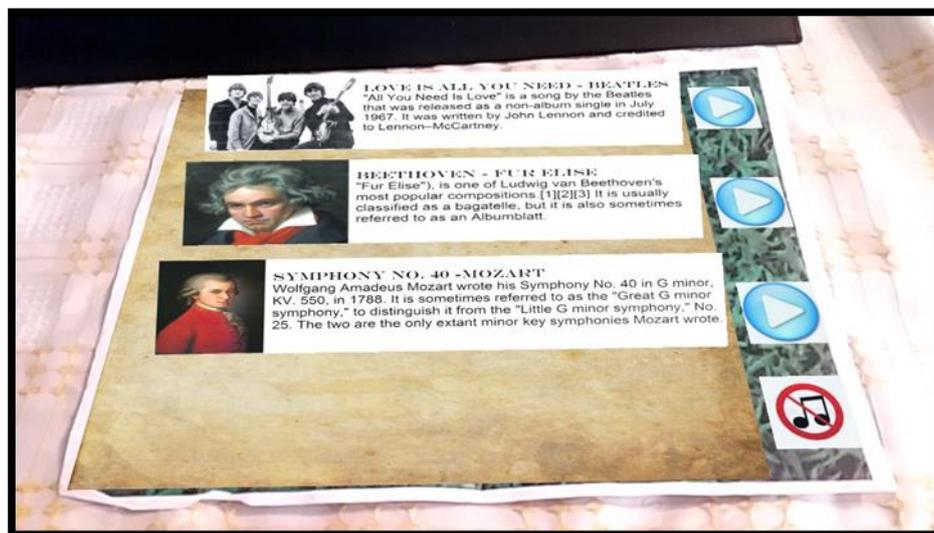
Fig. 1 – screenshot of Virtual Reader

Comparing with other existed similar AR apps, our app includes many features designed specially for improving the interaction with users, enhancing the communication of information. We proposed the following new features:

- Virtual buttons, that can be pushed by inserting your finger or hand between you camera and the 2D model (Fig. 1). The app recognizes the lose of visual contact with the marker specific to the button as a key press event and acts accordingly.

- Virtual photo album with 3D images. The photo album was simulated by adding multiple 3D objects corresponding to a single image. It is possible to swipe forward or through these 3D images by using two virtual buttons.

- Incorporating audio information on top of additional visual information. In our app, one of the marker incorporating images also allows you to play, pause or mute one out of a selection of 3 songs by pushing virtual buttons, but other kind of audio information could be incorporated as well. (Fig. 1).

Using the features enumerated above we are able to add a lot of additional information by using a single image as a base. As an example, we considered a 2D image of Michelangelo as a marker base on top of which we created an entire album of his best works, paintings, and sculptures. The user can browse the volume using virtual buttons. Additional audio information was incorporated, enhancing the user experience and improving the communication of information. This type of display could be used for any 3D object.

The main advantage of the Virtual Reader App when comparing withother AR apps is the fact that the user is able to interact with the virtual environment directly by touch. At the moment, Virtual

Reader touch is limited to pushing virtual buttons; but the level of interaction between the app and the user. can be expanded. Another feature of Virtual Reader is the possibility of transmission of both additional visual and audio information.

For testing the impact of the new proposed features, we presented our app at the event Sibiu Researchers' Night 2016 and 2017 [14]. We discovered that users were more than eager to try and interact with the app. The app was intuitive to use, therefore no prior description or tutorial is required before using Virtual Reader. There were some issues with the identification of the markers if the smartphone was held too tilted. Therefore, a further direction of study is to fix the issue of marker recognition in difficult environments.

2.2 Virtual Pathfinder

We also developed a markerless AR app in order study the advantages and disadvantages of a markerless AR. A markless AR app is much more difficult to develop compared with a marker based AR app because we are not able to pre-program the information which the app should respond to. It is quite difficult to create a general algorithm that will respond to unplanned situations accordingly. Recognizing new scenarios is a task related more to the artificial intelligence field than to the virtual reality one. To overcome this difficulty additional information that substitutes the markers should be taken into account. The most difficult task is to introduce this additional information in the algorithm. In our AR app we use GPS coordinates as additional information.

The purpose of Virtual Pathfinder is to help the user get from his current location to his desired destination. In order to achieve this Virtual Pathfinder uses the smartphone's built in GPS system to draw a route. The main difference from our AR app and a usual navigation app is that the route is represented not only on a 2D plane but on a 3D plane as well. The app differences itself by adding another layer of information on the smartphone's video feed, combining the smartphone's GPS location with the camera video information in order to create 3D virtual cues. These cues are represented either by intermediary signs such as arrows that point what direction you need to follow or by a continuous line that you need to follow in order to reach your destination (Fig. 2).

Fig. 2 – screenshot of Virtual Pathfinder

We encountered multiple technical challenges, out of which most notable were the representation of the representation of the AR elements on to the smartphone screen and the access to maps that would help us navigate the user. We solved this issue representing the 3D images on top of the real world camera feed by inserting another layer/canvas between the smartphone's screen and the video feed. As a result we were able to project our virtual signs on the smartphone's screen indifferent of the position in which the camera was pointed.

Accessing the map information (cities, streets, landmarks) proved to be more challenging than we had estimated. We were unable to access the information from Google Maps in order to implement it in our app due to terms of agreement infringement. Therefore, we personally mapped a small portion of the city (Sibiu) for demonstration purposes.

As far as we know Virtual Pathfinder is the only app that integrates live virtual feedback with GPS mapping. Virtual Pathfinder offers clear and concise information by showing what route the user needs to follow. The route is depicted in real time on the smartphone (Fig. 2). The additional virtual elements provided more precise directions that the user would follow, this was especially true on the intertwined streets of Sibiu. If you are able to see exactly the direction or path that you need to follow, the possibility of making a bad turn is reduced. We found two major points that we need to work on in order to take Virtual Pathfinder to its next level. First, we need to find a reliable and open access source of maps. Secondly we need to find a way to reduce the battery consumption of the app because using both GPS and the smartphone's camera is quite draining for the battery.

3 Conclusions and further directions of study

The purpose of this research is to study how Augmented Reality can be used to improve the communication of information between computer and users. Our constructive method allowed us to find new features that can be added to a AR app in order to enhanced the interaction with users and to find new directions of study. When we developed Virtual Reader, an AR app based on markers, we discovered that it is possible to compress a lot of information into an AR marker. The marker can be used not only for information storage but also for simulation of virtual elements such as virtual buttons or virtual albums. When we developed Virtual Pathfinder, a markerless AR app, we discovered that AR can be used to improve functionalities that already exist. Furthermore we consider that Virtual Pathfinder provides precise information that couldn't be delivered to the user by any other means than augmented reality. The markerless AR apps need to use additional information to substitute markers. This is the most difficult element of the design of this type of AR apps. One of the most important problem a markerless Ar apps focuses with is the to battery consume problem, due to the necessity of using additional information required to substitute the markers.

In conclusion augmented reality is convenient to be used for providing additional information for the user. It is much more efficient to display information with the help of AR than to input data with AR.

As mentioned by Robert Scoble in his book *The Fourth Transformation* [15] we are approaching a new era.: an era in which we will interact with computers through the use of AR. As a further direction of our study we intent to make a comparison of the AR apps performances taking into account the devices implied in the design and use of these apps.

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SĂNDICĂ ROBERT
"Lucian Blaga" University of Sibiu
Faculty of Sciences
Dr. Ratiu Str 5-7
Romania
e-mail: sandica_robert@yahoo.ro

PETRICĂ BOTA
"Lucian Blaga" University of Sibiu
Faculty of Sciences
Dr. Ratiu Str 5-7
Romania
e-mail: botapetre1@gmail.com

DANA SIMIAN
"Lucian Blaga" University of Sibiu
Faculty of Sciences
Research Center ITI
Romania
e-mail: dana.simian@ulbsibiu.ro