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DESIGN A LOW-COST EYEWEAR DISPLAY ADAPTED TO ADDITIVE MANUFACTURING

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Abstract: *This paper presents the design process of HMD equipment made from plastic. This equipment has been specially designed to be manufactured using 3D printing processes. The equipment case represents an eye wear device that has been designed to be compatible with different types of mobiles phones and various accessories such as the Leap Motion sensor or external battery banks in order to obtain a greater autonomy of all the devices connected to the HMD equipment.*
Keywords: *Design, CAD, 3D print, Head-Mounted Display, manufacturing*

1. INTRODUCTION

As shown in Figure 1 on the HMD (Head Mounted Display) market at the moment there are two major categories of devices that share this market HMD Integrated (Helmet mounted display that uses integrated processing devices) and HMD with Mobile devices (Eyewear Display that makes use of a mobile phone`s display)

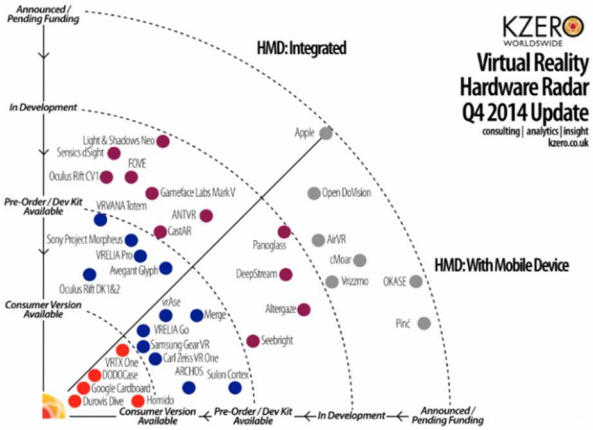

Fig. 1 HMD device on the market [1]

According to [2] in 2014 the market share between this two types of devices was in favor of Integrated HMD with a market share of 57.1%. According to the same study it is expected that by 2020 the entire market will be monopolized entirely around HMD that make use of a mobile device such as a smartphone or a tablet.

As presented in [3] the global HMD market is expected to reach $12.28 billion by 2020 at an estimated CAGR of 57% from 2014 to 2020.

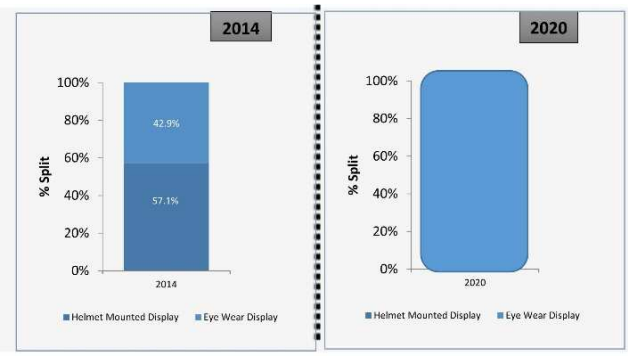

Fig. 2 Market share: helmet mounted display vs eye wear display

The most important customers in this market are expected to be Americans as market leader followed by Europe and then APAC.

In [4] is presented a list with US patent holders, companies that are actively patenting in AR and HMD devices. With an estimation of 7900 patents in 2015, we can say that the innovation is constantly developing these types of equipment. According to [4] these patents cover a broad array of technologies specific to the augmented reality space, from display hardware and semiconductors, to software that drives image processing, network connectivity, and personalized content delivery.

A simple search in the two most popular application stores for smartphones and tablets

such as Google Play and AppStore reveal the fact that there are several hundreds of applications that can be used with these types of equipment. And the number of these types of application is constantly growing.

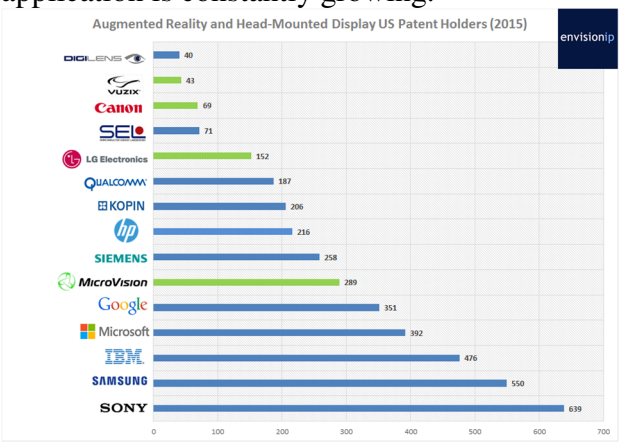

Fig. 3 US patent holder for AR and Head mounted device

This paper objective is to present a new innovative case for HMD that is designed for additive manufacturing technology for home users. This case has been designed to fit big varieties of smartphones as well as other devices which can improve the interactivity of the user within the virtual environment.

2. DESIGN AND MANUFACTURING

As presented in [1] wearable computing is rapidly becoming an exciting new market that has advanced well beyond the realm of science fiction speculation, and clumsy early prototype devices.

The idea behind building a low cost HMD that makes use of different smartphones and its easy to use with minimal efforts has been presented in [2].

The design process began with a study of different HMD cases available on the market. The findings of this study revealed the fact that there are many models that do not allow the use of the image sensor available on smartphones. Some manufacturers have created special HMD that allow the use of this sensor but their main limitation is often related with the screen size of the smartphone. Most smartphones manufactures place the camera sensor centrally on the vertical axis or in different areas that are offset from this axis. The second step of development involves the design specifications of the case so that it can incorporate different VR and AR devices.

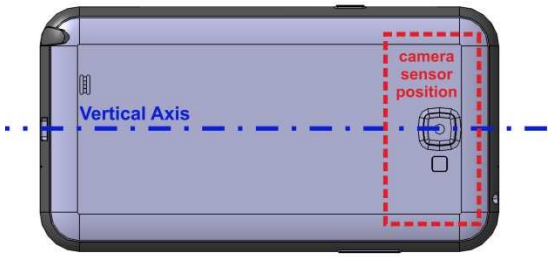

Fig. 4 The most common location for the smartphone camera

Starting with the smartphone – leap motion combination used by the Samsung`s GearVR devices the following required elements have been identified: an external battery that would allow an increased phone autonomy, a laser pointer, a sphere and reflective target used by the tracking system, a NFC sensor and the Leap Motion sensor.

The 3D model of the case designed with regards to the design specifications listed above is illustrated in Figure 5.

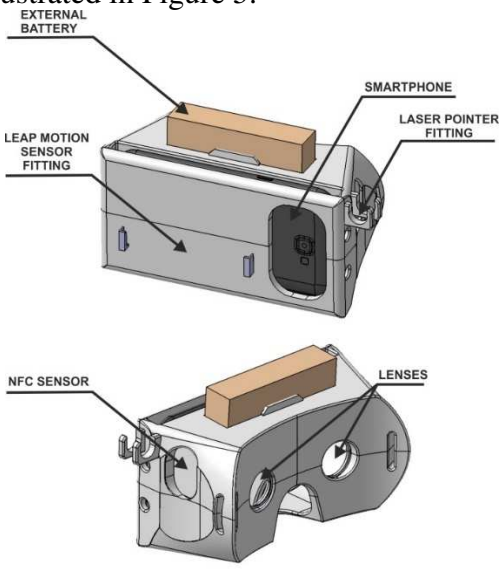

Fig. 5 The proposed HMD design

Having the 3D model of the case designed according to the design specifications the model needs to be optimized so that it's adapted for 3D printing manufacturing. Figure 6 illustrates the layers simulation within the 3D printing software solution.

In order to obtain a 3D printed HMD case that is lightweight, strong and with a low plastic

consumption it is necessary to combine filled areas within the case wall with empty areas for

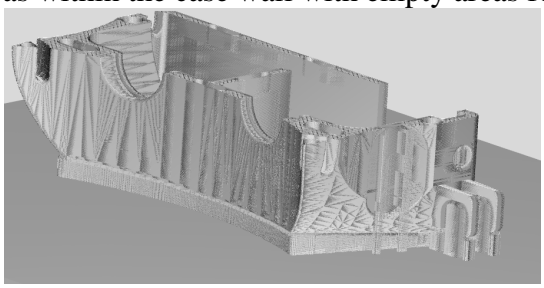

Fig. 6 3D printed layers simulation

which the 3D printer will only apply material for the interior and exterior wall and a hatch support design. Figure 7 illustrates two different steps within the 3D printing process of the top part of the HDM case. As it can be seen there are some areas where the volume of plastic material used is reduced by printing a support within the case walls.

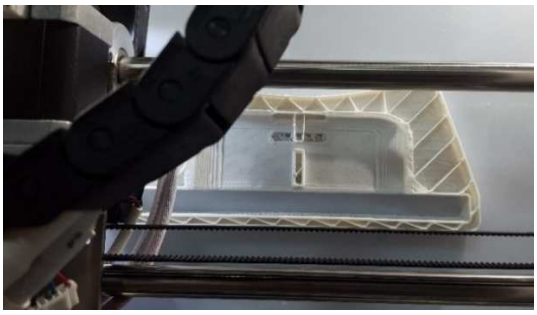

Fig. 7 The 3D printing process

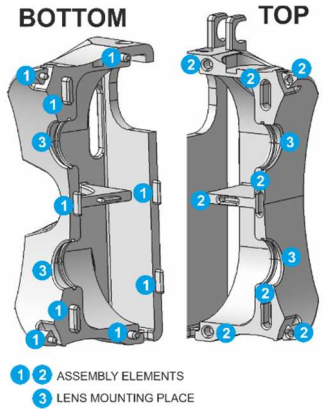

Fig. 8 The designed assembly elements

In order to facilitated the assembly of the two case parts (bottom and top) the 3D model has been designed with a number of nine elements that ensure a good assembly. These elements are illustrated in Figure 8.

The extra battery bank is fixed using two clamps. When larger batteries are required another fixing element can be printed according to the battery bank dimensions and it can be placed over the standard battery slot.

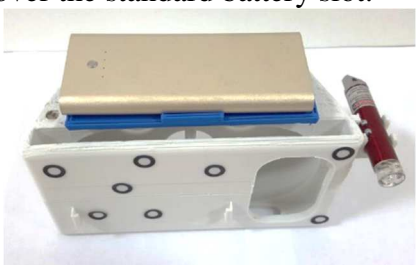

Fig. 9 Support for extended battery

Regarding the tracking systems used within this HMD case there are three different systems that have been integrated: reflective targets that can be mounted on the front of the case, a laser pointer and a positioning sphere.

Fig. 10 Accessories used by the tracking systems

Fig. 11 The custom frame for other smartphones with a different size

Because only a single tracking system will be used at a specific time the tracking sphere will be mounted in the same place as the laser pointer within a custom 3D printed fixing element.

In order to facilitated multiple smartphone with different sizes a special frame can be printed as shown in Figure 11 that would allow the automatic centre positioning of the phone in front of the lenses so that each divided part of the screen is assigned to a single eye.

3. RESULTS

Figure 12 presents the two plastic enclosures and different accessories used with the proposed case design. The weight of the case without any accessories is around 210 g and the 3D printing time required to manufacture this prototype with a CubePro 3D Printer is about 9 hours.

Fig. 12 HMD case and accessories

The final case with all the required accessories that were required within the design specifications of a HMD suited for VR and AR applications is illustrated in Figure 13.

Fig. 13 The assembled HMD case and its accessories

4. ACKNOWLEDGEMENT AND DISCLAIMER

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PROIECTAREA UNUI ECHIPAMENT PENTRU AFIȘAREA MEDIILOR VIRTUALE ADAPTAT PENTRU FABRICAȚIA ADITIVĂ

Abstract: Lucrarea prezinta procesul de proiectare unui echipament de tipul HMD. Acesta este special proiectat pentru a putea fi realizat prin printare 3D. Carcasa este de tipul eye wear display si aceasta fost conceputa pentru a putea fi utilizata cu mai multe tipuri de telefoane si cu diferite accesorii precum senzorul Leap Motion sau baterii suplimentare pentru a oferii o autonomia mult mai mare a tuturor dispozitivelor conectate acestui echipmanet.

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