ISSN:0975-9646

Hemant Surale et al, / (IJCSIT) International Journal of Computer Science and Information Technologies, Vol. 5 (3) , 2014, 3726-3728

A Design of Low Cost Head-Mounted Display Using Android Smartphone

Hemant Surale[1], Prof. Sagar Shinde[2]

[1]*Co-Organizer*
IoTBLR - Internet of Things Bangalore, Bangalore, India

[2]*Computer Engineering Department*
MES's College of Engineering, Pune-01

***Abstract*— Smartphones and tablets are the most popular devices because of lightweight, mobile and high-end computational capabilities. Android operating system based smartphones are widely used covering major portion of global smartphone shipment market. This paper proposes a new novel design of a Low Cost Head-Mounted Display (LCHMD). LCHMD is using android operating system based smartphone as a display module. The model implements an android application that is responsible to present stereoscopic 3D content over Smartphone's screen. Since modern Virtual Reality (VR) glasses and Head-Mounted Displays are costly, proposed model is efficient terms of cost and time required to build HMD from scratch.**

***Keywords* - Virtual Reality, Stereoscopic, Head-Mounted Display, android operating system.**

I. INTRODUCTION

Head-Mounted Display (HMD) is a display device that has small display in front of one eye knows as monocular HMD or that present image in front of each eye knows as binocular HMD. Head-Mounted Displays (HMD) is personal information-viewing devices that can provide information in a way that no other display cans [1].

Google Glass is one of the examples of monocular HMD and oculus rift HMD is an example of binocular HMD. We have developed a low cost design for binocular HMD using android smartphone which has 5 inches display. The android operating system (OS) based smartphone has to install the application which we have developed to present two identical images of single scene to each eye. The idea of displaying two identical images of same scene to each eye also referred as stereoscopic 3D [2] display. Human eyes are separated approximately by 6 centimeters which allows eyes perceive image with different angles and perspective and thus allowing a sense of depth. This vision is called as Binocular Vision.

This approach minimizes the cost of building binocular HMD without sacrificing the desired experience of watching 3D contents. The model is based on LCHMD prototype that demonstrates the design using android operating system. Android operating system is primarily designed for smartphones and tablets computers based on Linux kernel with a user interface. End of 2013 developer survey conducted found that 80% of mobile developers develop for Android which helps us to choose android based smartphone as a display module for LCHMD.

II. LITERATURE SURVEY

A design for a smartphone based HMD [3] is a costly solution and less effective as to change the size of an image shown to each eye will need to change the display size of iPhone. Moreover, using two iPhone itself is a costly choice and there is a refresh synchronization issue between two iPhones. Epson's Moverio BT-200 [4] is a side-by-side 3D technology but it is a see-through display and the display size is much smaller. Moverio BT-200 tries to place a TV screen 16.4 feet away which is quite a user experience killer. Moverio BT-200 uses see-through display which limits the clearly of pictures that user can see. Oculus Rift a virtual reality headset making company has launched a developer kit [5, 6] which is a Virtual Reality (VR) gaming headset which uses proprietary design consists of Organic LED display, head movement tracker and lens holding assembly. However, Oculus Rift headset is specifically designed for gaming applications and yet to release end user version. Oculus Rift doesn't have ear plugs and user have to buy separate headphones to listen. Ozan Cakmaci and Jannick Rolland have presented a comprehensive review of head worn display [7].

The average cost of HMD that are available in market is approximately around $600, which is significantly more. Academic researchers, students and enthusiasts who wish to try out HMD are reluctant to buy overly priced devices and thus we propose a new Low Cost HMD based on android smartphone. The detailed design is discussed in next part of paper.

III. DESIGN OF LOW COST HMD

The idea behind building LCHMD is to allow android smartphone users to make an easy-to-use HMD with minimal efforts.

A. Basic Building Blocks of LCHMD (as shown in figure 1)

- HMD body: To reduce the overall weight, fiber is used as a building material for HMD body.
- Spectacle's Wireframe: Wireframe is made up of iron and coated with plastic material. It is same as conventional spectacles used in market.
- Lenses: Lenses of +6.75 Dioptric spherical lenses for each eye.
- Ear Plugs: They are connected to the 3.5mm audio jack of mobile phone and will deliver high quality audio over the ear.

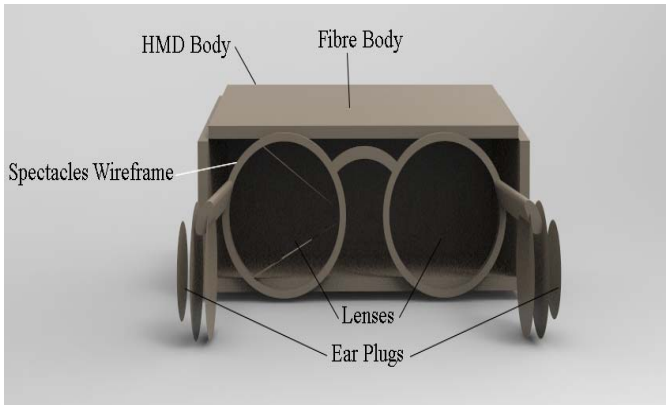

Fig 1: Basic block diagram of Low Cost Head Mounted Display.

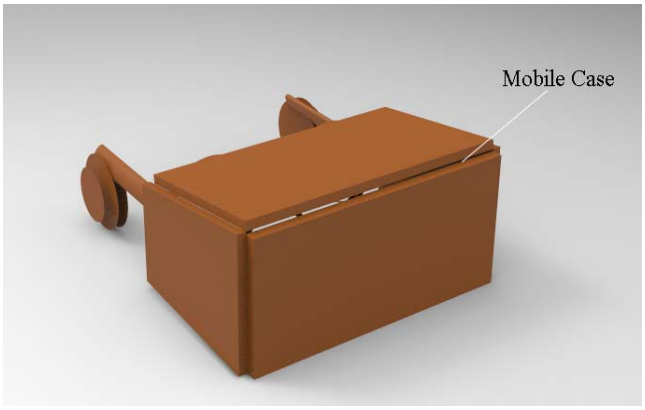

Fig 2: Left-Front view of LCHMD

B.Mobile Case

User has a provision to place the smartphone in the front case as show in Fig 2. User has to remove the upper cover of HMD body and place a smartphone inside. Here, in Fig 2, it is stated as Mobile Case. The display of a mobile is facing spectacles wireframe in turn user's eyes.

Once user placed the smartphone into the Mobile Case, he will able to see the stereoscopic video as shown in Fig 3 with help of stereoscopic video player. We have successfully experimented the setup - Samsung Galaxy Grand Duos, android operating system version 4.1.1 and 1 GHz processing power.

Stereoscopic video player is an android OS based smartphone application to play any video file as a stereoscopic 3D video over smartphone screen. The details of stereoscopic video player are discussed further.

IV. ANDROID APPLICATION

There are two ways that user can play video files as a stereoscopic 3D video.

1) Manual Method: by converting a video to stereoscopic version and then upload in mobile. This method is suitable for the mobiles which don't support OpenGL.
2) Stereoscopic video player: We have implemented an android application that will convert/play any plain video to stereoscopic video on the fly. User will need to only select a media to play and application will handle the rest. Screenshot of actual application is shown in Fig 3.

Fig 3: Stereoscopic video player for smartphone.

A. Pseudo code of android application

a) Start
b) User will set the path of video file to be played.
c) Get the path of video file.
d) Divide a screen of android smartphone logically into two equal parts namely A and A'.
e) As shown in Fig 3, Play a video file frame by frame in left side 'A' and copy each frame into the right side 'A'.
f) Repeat step 'c' till video stream is not finished.
g) End.

Step 'e' is faster enough to avoid observable glitches by human eye. Logically dividing a single screen to display images to each eye makes HMD efficient. There is no lag observed occurred due to refresh synchronization issue present in similar work previously done by J. Logan Olson, David Krum [1].

B. Arrangements of Units

The arrangement of different units is shown in Fig 4.

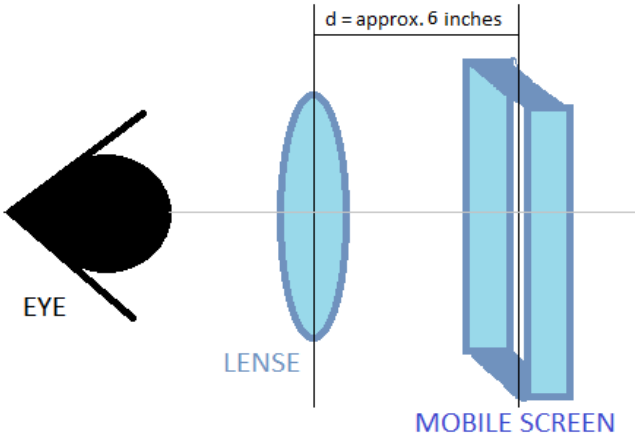

Fig 4: Linear arrangement of units

Size of the whole unit i.e. HMD depends on the distance'd' (d = distance between mobile screen and lens). 'd' can be controlled by the power of lens.

C. Equation

The relation between power of lens and distance'd' is explained below.

Power of Lens (in Diopter) = 1/ Focal Length (in Meters)
Where,

Diopter is measurement of power of lens.

We can calculate the required power of lens based on distance and vice versa. We have used converging lens (+ve) with power 6.75 DSph (Dioptric Spherical) and'd' is 5.832 ≈ 6 inches.

Developers can use LCHMD design with head tracking technology [8] to create more immersive experience. Unity game development engine has such provision to harness the power of sensors - accelerometer and gyroscope, to keep track of head movement and adopt the visual perspective of user to present the image to each eye. Moreover, Mobile application developers can extend a module that stream a laptop/desktop/TV screen to stereoscopic video player of mobile and use LCHMD as an alternative display to conventional display.

Our motivation behind building the LCHMD is to provide a low cost design that can be widely adopted by educational institutes or hobbyist.

V. CONCLUSION & FUTURE SCOPE

The approach demonstrates the low cost and efficient design for building a head-mounted display. We have used widely accepted, android, smartphone operating system and easy to configure setup. This novel approach open ups numerous opportunities to use LCHMD as a virtual reality or augmented reality glasses. LCHMD can also be used to manipulate and enhance human visual experience. With LCHMD we share an opportunity to experiment and create more efficient design for wearable display devices.

Future work for LCHMD is to experiment with widescreen mobiles and wearable controllers to interact with stereoscopic video player. It would be also possible to add 3D head motion tracking to enhance the user experience.

If a video stream from TV/Laptop/Desktop/other electronic device is fed to stereoscopic video player, the wearable controller will add ease of use to interact with digital contents presented over smartphone display. Another modification would be to reduce the distance between spectacles wireframe and mobile display by placing more powerful lens.

REFERENCES

[1]. James E. Melzer, "Head-Mounted Displays" Kaiser Electro-Optics Inc.

[2]. Wikipedia.com, "Stereo Display. Internet: http://en.wikipedia.org/wiki/Stereo_display". April 16, 2014 [April 16,2014]

[3]. J. Olson, David Krum, Evan Suma and Mark Bolas, "A Design for a Smartphone-Based Head Mounted Display", IEEE Virtual Reality 2011, March, Singapore.

[4]. Epson.com, "See Through Smart Glasses. Internet: http://www.epson.eu/ix/en/viewcon/corporatesite/products/mainunits/specs/12411".

[5]. Oculusvr.com, "Announcing the oculus rift DK2. Internet: http://www.oculusvr.com/blog/announcing-the-oculus-rift-development-kit-2-dk2/".

[6]. Wikipedia.com, "Oculus Rift. Internet: http://en.wikipedia.org/wiki/Oculus_Rift".

[7]. Ozan Cakmaci and Jannick Rolland, "Head-Worn Displays: A Review", Journal of display technology, Sept. 2006.

[8]. George Hsu "A Sourceless, Low-Cost Head Trackerfor Virtual Reality Head Mounted Displays" ISBN# 0-7803-2636-9