

## COMPARISON OF VARIOUS EPSON SMART GLASSES IN TERMS OF REAL FUNCTIONALITY AND CAPABILITIES

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**Keywords:** smart glasses, Epson Moverio, mobile streaming.

**Abstract:** *The article presents some experiences with the smart glasses developed by Epson, namely Movrio BT-200, BT-300 and BT-2000. We conclude that they are on the right track, good devices, however, are still in an incipient, before the market stage and need a lot of technical (both hardware and software) improvements to be up to the needs of the real market.*

### 1. INTRODUCTION

The wearable technologies are smart electronic devices (electronic device with microcontrollers) that can be worn on the body as implant or accessories. They are designed for specific practical functions and features [1]. At this moment, the most advanced wearable devices are the smart glasses, as they tend to be economically functional and useful [2]. However, the most widely-spread are smart watches and bracelets, used for step counting [3], heart beat measurement [4] or activity recognition [5].

Examples of other wearable devices include contact lenses, e-textiles and smart fabrics, headbands, beanies and caps, jewelry such as rings, bracelets, and hearing aid-like devices that are designed to look like earrings [6].

Smart glasses available on the market are:

- ✓ ODG R7-9, [7],
- ✓ Lumus Vision DK-50, [8],
- ✓ Epson Moverio BT 200, 2000 and 300, [9].

## 2. SMART GLASSES AT THE STAKE

Beyond the marketing messages, we needed a pair of smart glasses capable of apparently basic functionality, but in real world. The most widely known and used glasses are Google Glasses, respectively a suit developed by Epson. However, according to [7], Google dropped the project in 2015 and Epson improved his products. We preferd them also because they use Android and not proprietary operating systems. The three glasses are: Moverio BT-200, BT-2000 ad BT-300, detailed further.

Table 1. Epson Moverio BT-200 characteristics

CPU	TI OMAP 4460 1.2Ghz Dual Core
RAM	1 GB
Internal Memory	8 GB
External Memory	microSD (max.2GB) / microSDHC(max.32GB)
Battery Type	Li-Polymer [2720] mAh
Wireless LAN	IEEE 802.11b/g/n with WiFi Miracast
Bluetooth	3.0
Camera	VGA
OS Version	Android [4.0.4]
LCD Size	0.42 inch wide panel (16:9)
LCD Pixel Number	518,400 dots [(960×540) x 3]
Sensors	Compass, Gyroscope, Accelerometer, GPS
Weight Headset	Approx. 88 g (without light Shielding and harness)
Weight Controller	Approx. 124 g



Figure 1. Epson Moverio BT-200

Table 2. Epson Moverio BT-2000 characteristics

CPU	TI OMAP 4460 1.2Ghz Dual Core
RAM	1 GB
Internal Memory	8 GB
External Memory	microSD (max.2GB) / microSDHC(max.32GB)
Battery Type	Li-Polymer 2x 1240mAh
Wireless LAN	IEEE 802.11b/g/n with WiFi Miracast
Bluetooth	3.0, BLE
Camera	5 megapixel stereo camera
OS Version	Android [4.0.4]
LCD Size	0.42 inch wide panel (16:9)
LCD Pixel Number	518,400 dots [(960×540) x 3]
Sensors	Compass, Gyroscope, Accelerometer, GPS
Weight Headset	Approx. 88 g (without light Shielding and harness)
Weight Controller	Approx. 124 g



Figure 2. Epson Moverio BT-2000

Table 3. Epson Moverio BT-300 characteristics

CPU	Intel Atom x5, 1,44Ghz Quad Core
RAM	2 GB
Internal Memory	16 GB
External Memory	microSD (max.2GB) / microSDHC(max.32GB)
Battery Type	Li-Polymer 2950mAh
Wireless LAN	IEEE 802.11b/g/n with WiFi Miracast
Bluetooth	3.0, BLE
Camera	5 megapixel
OS Version	Android [5.1]
LCD Size	0.43 inch wide panel (16:9)
LCD Pixel Number	921,600 pixels (1,280x720) x RGB
Sensors	Compass, Gyroscope, Accelerometer, GPS
Weight Headset	Approx. 69 g (without light Shielding and harness)



*Figure 3. Epson Moverio BT-300*

### 3. RESEARCH METHODOLOGY

Going from very specific, real life needs, we tested the glasses on an app developed by HOLISUN and Intellisoft Association. The app has been developed for recognizing a dominant colour in an image captured by the glasses. The app takes some sample frames (1 frame per second) and makes a histogram for that image to calculate the dominant color. After calculation of the dominant color the app shows the dominant color and the name of color in a box.

**The second app**, more complex, has been used for audio and video streaming. The streaming app uses WebRTC technology. **WebRTC** is a collection of communications protocols and application programming interfaces that enable real-time communication over peer-to-peer connections. This enables applications such as video conferencing, file transfer, chat, or desktop sharing without the need of either internal or external plugins. This app works on mobile (preferred 3G or 4G networks) and wifi networks (with or without proxy).

### 4. COLOUR DETECTION EXPERIMENTAL RESULTS

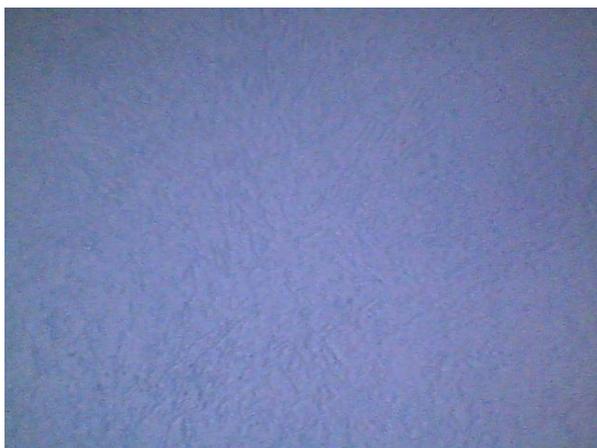
We detected many problems in using the Moverio BT-200 glasses for colour detection.

**White colour** - is not a colour and reflects the colours around. Although the wall in *figure 4* is white, the camera captures a bluish image, reflected by another, exterior, blue wall.



*Figure 4. A white wall*

The *figure 5* is with a strong blue wall. As you can see, there is no significant difference between the colour in *figure 4* and *figure 5*. The camera makes almost no difference between the two in terms of colour.



*Figure 5. A blue wall*

If the light is dimmed, the camera does not detect colours, but only grey-scale, as can be seen in *figure 6*.



*Figure 6. A dimmed-lighted capture*

The next three figures are a decomposition on 3 different chanel : Y, Cr, Cb.



Figure 7. The Y channel

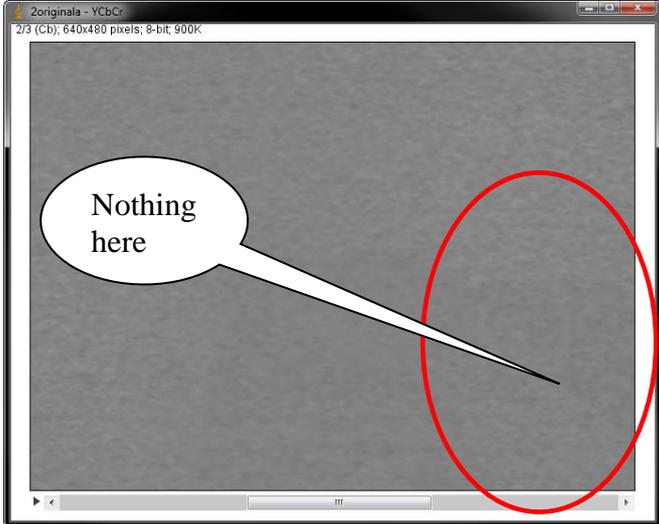


Figure 8. The Red channel

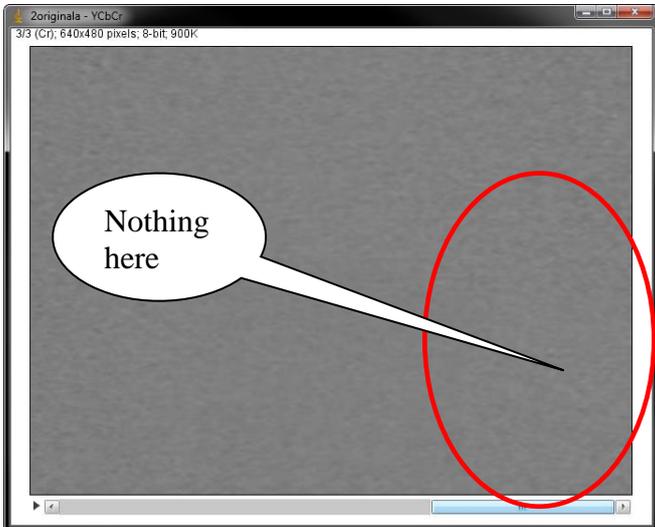


Figure 9. The Blue channel

Although the upper part of the stairs have a reddish colour, it is lacking the information on the two colour channels (Cb and Cr). A flat image on Cb or Cr means that there is no information about that colour on the specific channel. The only variations are given by the background noise.

As the camera of Moverio BT-2000 is 5MP but the quality of camera is poor, and of Moverio BT-300 is also 5MP but the quality is much higher than Moverio BT-2000, these problems do not occur. However, by default the camera of BT-2000 is overexposed and this is not possible to be adjusted with the input interface provided. An extra bluetooth mouse is needed for that.

## 5. CONCLUSIONS

In this article we compare three models of smart glasses developed by Epson, namely Moverio BT-200, Moverio BT-2000 and Moverio BT-300.

Our findings are concluded in Table 4

Table 4. A comparison between the three models of smart glasses

Feature	Moverio BT-200	Moverio BT-2000	Moverio BT-300
Camera	VGA	5 mp	5 mp
Input device	touchpad	d-pad navigator	touchpad and d-pad navigator
Android version	4.0.4	4.0.4	5.1.1
Colour detection	Very poor	Pretty good	Very good

Table 5 presents the advantages, respectively the disadvantages of the three models.

Table 5. The advantages and disadvantages of the three models of smart glasses

Model	Advantages	Disadvantages
<b>BT-200</b>	<ol style="list-style-type: none"> <li>1. Light comparing with BT-2000</li> <li>2. Cheap (roughly 550 EUR)</li> </ol>	<ol style="list-style-type: none"> <li>1. Bad camera (VGA)</li> <li>2. Android 4.1, with no native support for image processing</li> <li>3. Bad hinges, easily breakable</li> <li>4. Easily losable on the head</li> </ol>
<b>BT-2000</b>	<ol style="list-style-type: none"> <li>1. Very fixed on the head</li> <li>2. Stereo cameras</li> </ol>	<ol style="list-style-type: none"> <li>1. Very heavy</li> <li>2. input device makes the access to some visual objects impossible (ImageView), only buttons can be clicked</li> <li>3. Impossible to adjust the camera exposure</li> <li>4. Need of a bluetooth mouse or keyboard for fully using it</li> <li>5. High and unjustifiable price (around 2800 EUR)</li> </ol>

<b>BT-300</b>	<ol style="list-style-type: none"> <li>1. Improved camera, therefore better quality of the images</li> <li>2. Uses Android 5.1, which is a significant step forward for image and video processing comparing with Android 4.1</li> <li>3. The lightest</li> <li>4. More resistant</li> <li>5. Reasonably cheap (700 EUR)</li> </ol>	<ol style="list-style-type: none"> <li>1. Does not support autofocus</li> <li>2. No zoom</li> <li>3. Easily losable on the head</li> </ol>
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