



Are Existing Head-Mounted Displays ‘Good Enough’?

A summary of a worldwide HMD survey on past experience and future expectations from HMDs

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Executive Summary

During the spring of 2007, Sensics conducted a broad worldwide survey amongst academic, commercial, and government users of virtual reality systems. The survey was designed to understand user perceptions of current head-mounted display (HMD) technology as well as desired performance characteristics of what was termed a “good-enough” HMD. A summary of these results is presented below.

Key survey findings include:

1. Most existing HMDs are not ‘good enough’ according to survey participants. Commonplace horizontal field of view (50 degrees or lower) and commonplace vertical field of view (30 degrees or lower) are considered ‘good enough’ by fewer than 10% of surveyed population.
2. The lack of ‘good enough’ performance is cited in practically all the cases where buyers with appropriate budgets considered purchasing head-mounted displays yet ultimately did not do so.
3. Users consider the most important HMD attributes to be: panoramic field of view (over 100 degrees horizontal), large vertical field of view (over 50 degrees), very fast dynamic response (no smear or fade effects), high contrast display, high resolution display and a lightweight design

We believe the HMD market is primed for innovation that will deliver HMD with acceptable characteristics. Products such as the Sensics piSight HMD (panoramic, high-resolution, upgradeable) already deliver many of the desired attributes and will continue to improve towards fully satisfying the needs of most professional users.

Participant Profile

Over 2,000 VR professionals were invited to participate in a Web-based survey. 218 responses were collected. The geographical distribution of respondents was as follows:

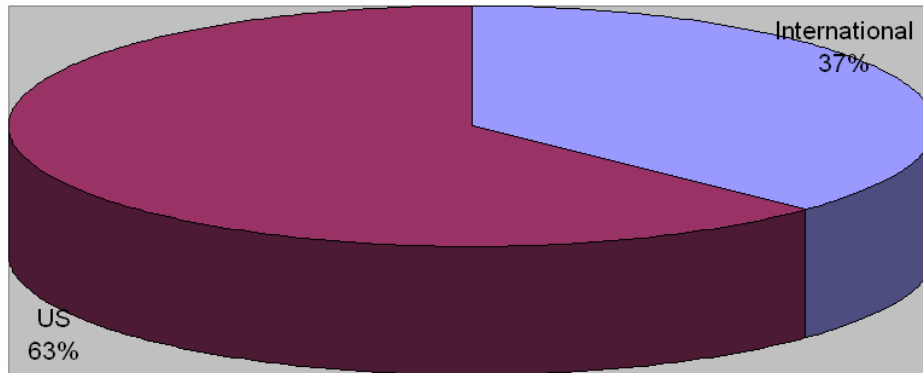


Figure 1 - Responses by Geography

Responses came from a wide range of organizations:

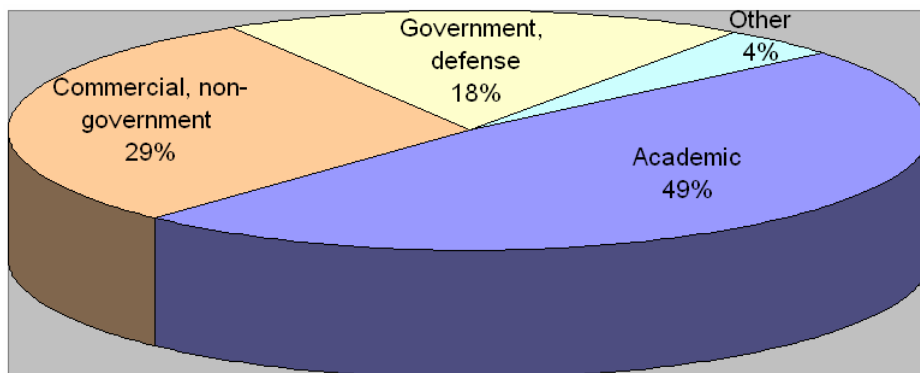


Figure 2 - Responses by type of organization

A large majority of participants report using HMDs today or an exposure to HMDs in the past. When asked “Do you use an HMD as part of your regular work?” responses were:

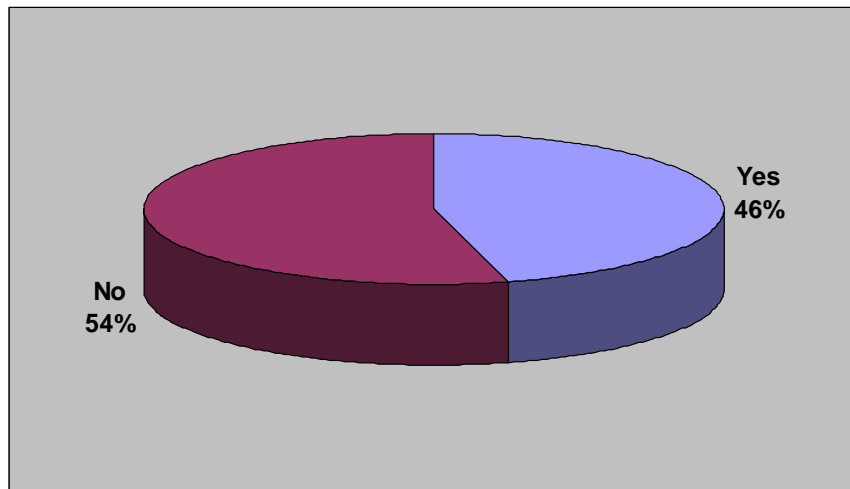


Figure 3 - Regularly Using HMDs?

The 54% that do not regularly use an HMD have mostly been exposed to HMDs before. In response to the question “Have you used HMDs in the past?”, the following answers were obtained:

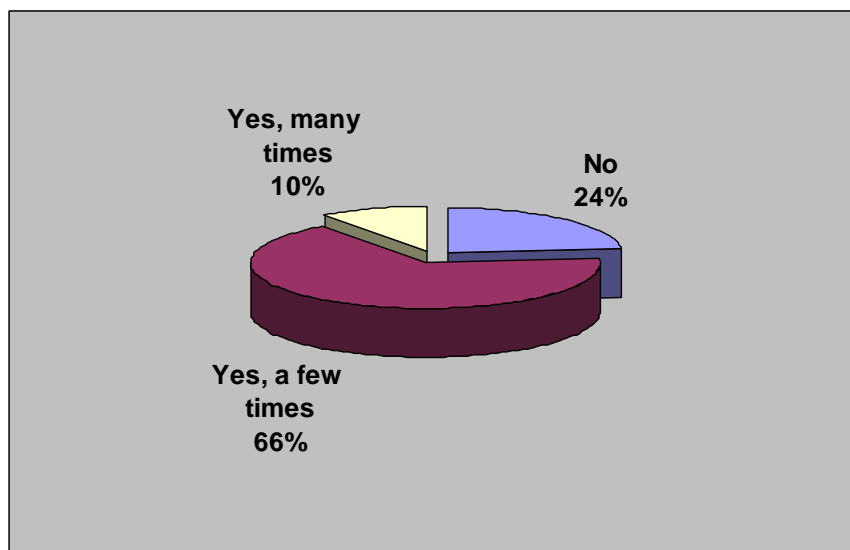


Figure 4 - Prior HMD usage amongst those that do not regularly use an HMD today

HMD usage applications were diverse. When asked, “Which types of applications do you use the HMD for”, the survey respondents that are using HMDs today reported a wide range of applications:

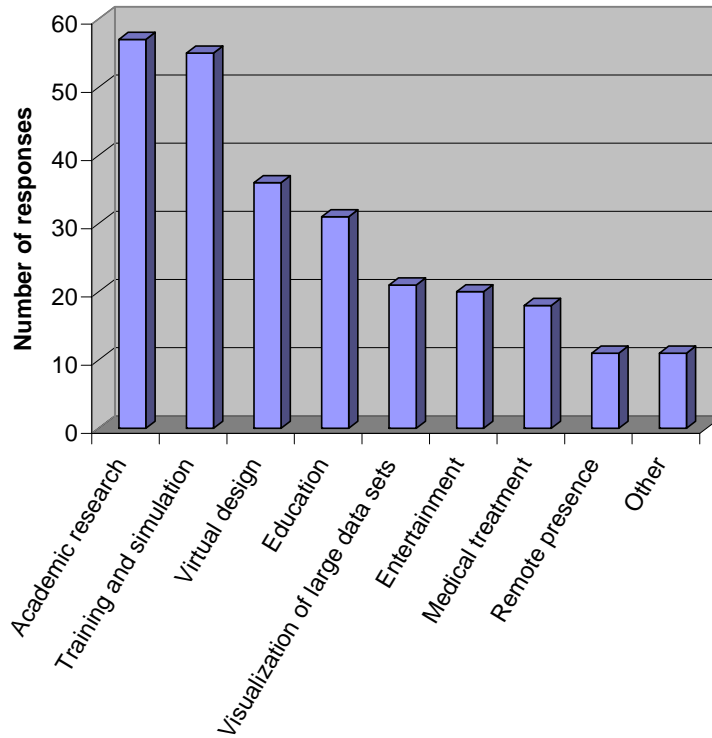


Figure 5 - HMD applications

Historical and Current HMD Usage Patterns

Per Figure 3, 46% of respondents are regularly using HMDs. For those 46%, the frequency of HMD usage is as follows:

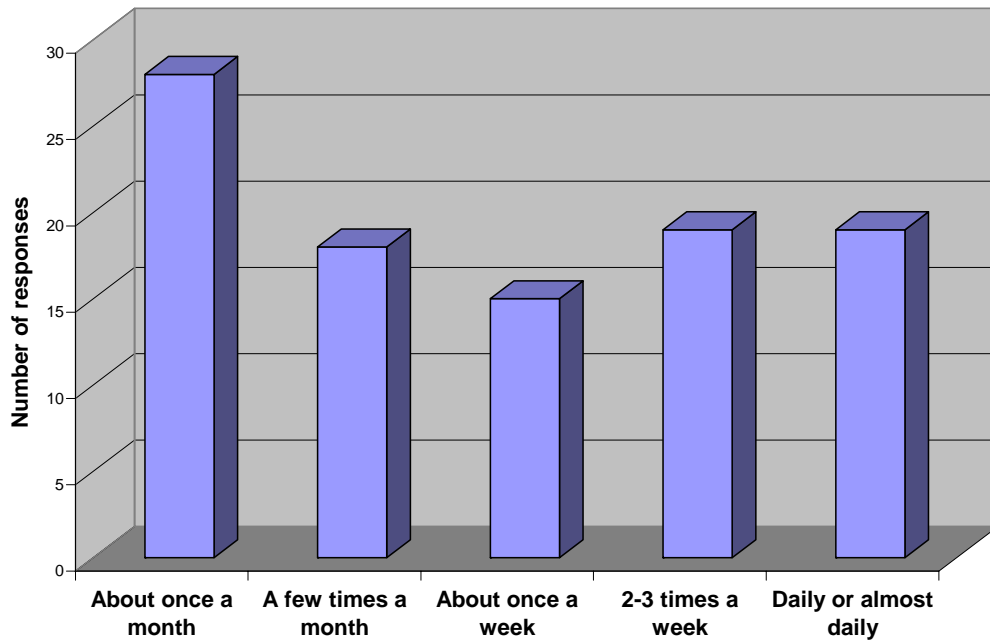


Figure 6 - Frequency of HMD Use

Since many respondents are not using HMDs yet were exposed to them, we asked whether an HMD purchase was ever considered. The responses were:

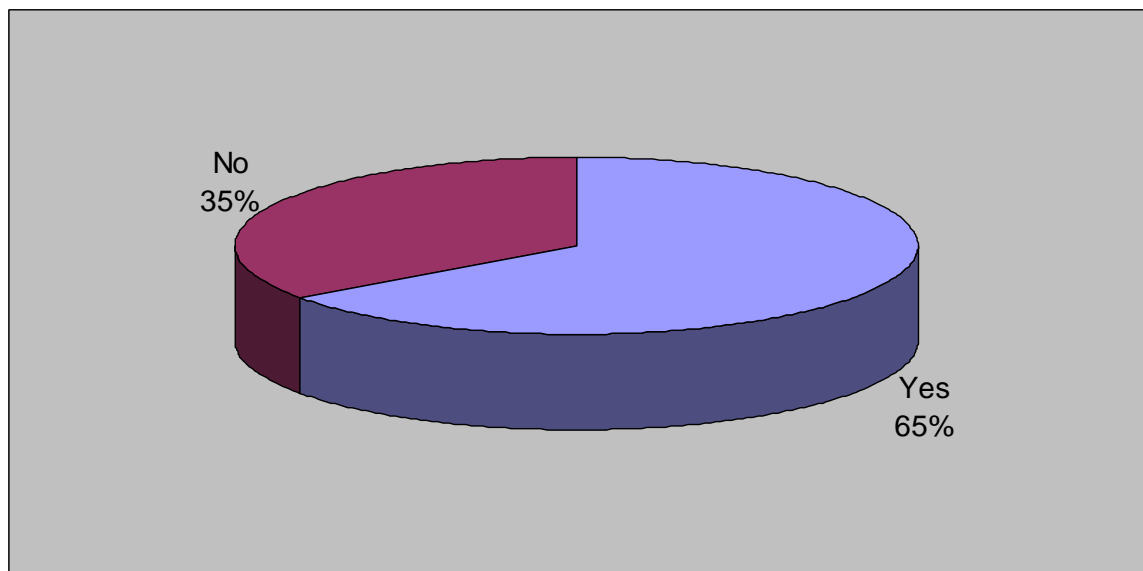


Figure 7 - Have non-HMD users previously considered buying an HMD?

Subsequently, we then explored the top reasons for *not* buying an HMD in the non-HMD user group that previously considered buying one. For those that did not mention price as a factor, the results were as follows:

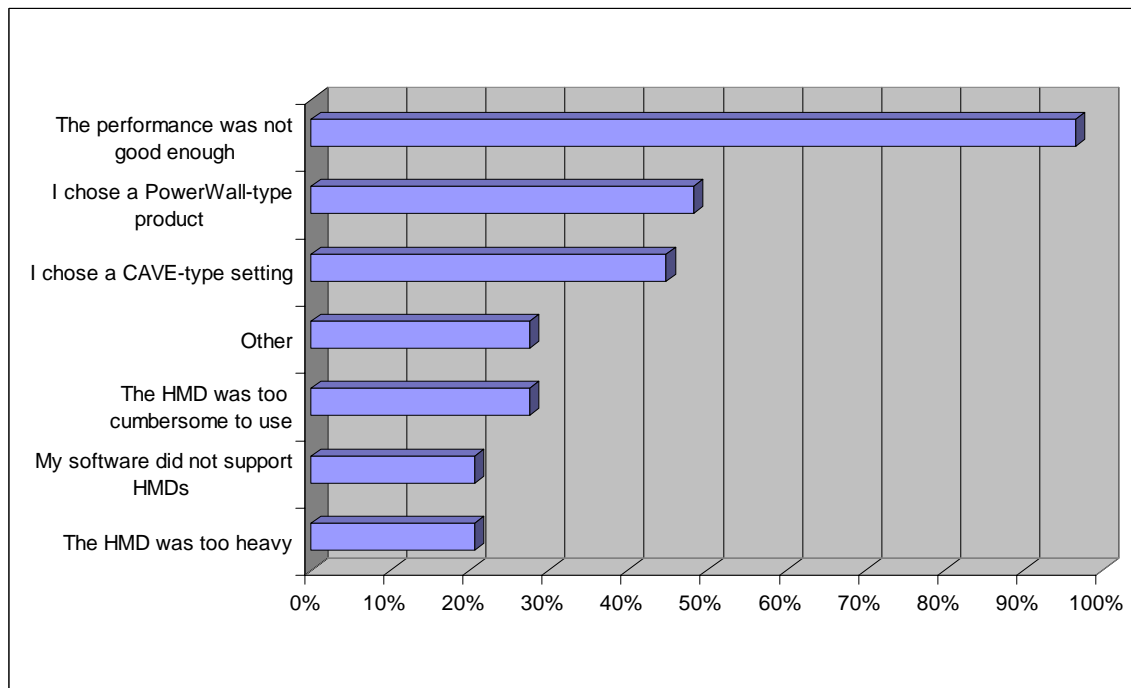


Figure 8 - Top Reasons for not buying an HMD

96% of users that did not buy an HMD after considering an HMD purchase report that performance was not good enough. Disappointed with their findings, nearly half of these users bought a projection-type system instead.



HMD Attributes that are Important to Users

We asked respondents to indicate the importance of several HMD attributes. Each feature was given an importance score on a scale of 1 (“completely unimportant”) to 6 (“very important”). We averaged the responses and grouped them into four categories based on that average score:

Attributes that received an average a score of 5 (“important”) or above include:

- A panoramic field of view (defined as “over 100 degrees horizontal”)
- A large vertical field of view (defined as “over 50 degrees”)
- Very fast dynamic response (defined as “no smear or fade effects”)
- High contrast display
- High resolution display
- A lightweight design

Attributes that received an average score above 4.5 both less than 5 include:

- A large binocular (stereo) overlap (defined as “50 degrees or more”)
- High resolution throughout the entire visual field
- A rugged design

Attributes that received an average score of above 4 (“somewhat important”) but less than 4.5 include:

- The ability to use the HMD at a considerable distance from the image-generating computer
- A product line that also has a see-through version
- Ability to incorporate live video into the HMD

Attributes that received an average score of less than 4 include:

- An HMD that includes stereo sound
- An HMD that can be carried in a briefcase
- A design that looks good

“How good is good enough?”

Given the user dissatisfaction with the performance of most HMD products (Figure 8), we asked survey participants a series of questions to determine what they would consider a ‘good enough HMD’. While we realize that most people would say “wide field of view is better than tunnel vision”, “high resolution is better than low resolution” and “lightweight is better than heavy”, we still wanted to understand ‘how good is good enough’ in quantitative terms.

When asked “What would be a ‘good enough’ horizontal field of view?” we received the following distribution:

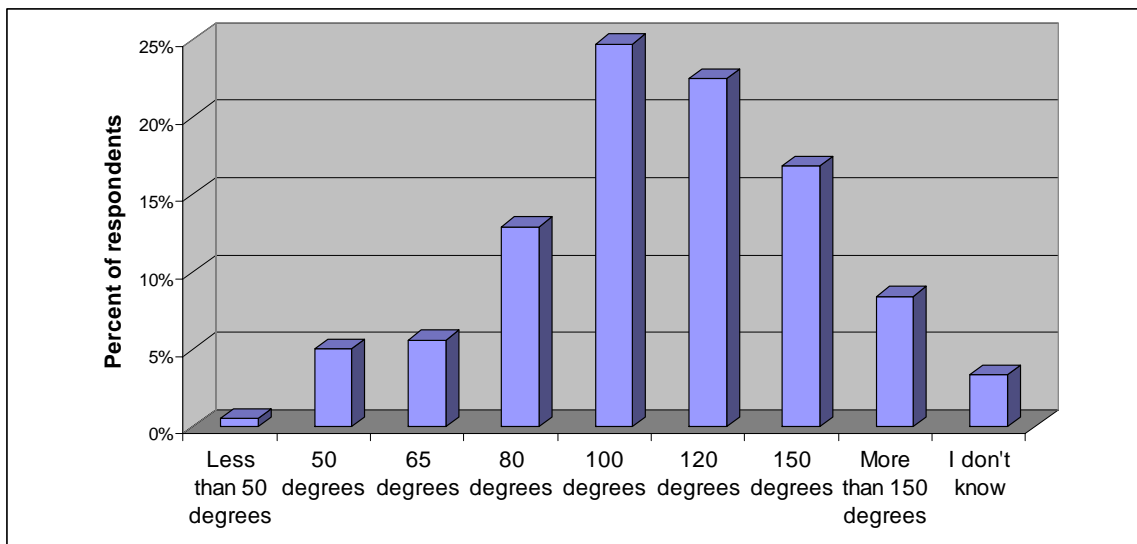


Figure 9 - ‘good enough’ horizontal field of view

Most HMD products on the market have narrow field of view and offer 50 degrees or less. This performance is hardly considered ‘good enough’: only 6% of respondents thought that a horizontal field of view of 50 degrees or less would be good enough for them. According to the survey, 120 degrees would satisfy about 75% of users.

Note that it is common practice in the HMD industry to specify *diagonal* field of view as the lead field of view characteristic. The horizontal and vertical field of view also depend on the aspect ratio of the display, but as an example, an HMD reporting 50 degrees diagonal field of view will typically have about 42 horizontal field of view and 25 degrees vertical field of view.

When asked “What would be a 'good enough' vertical field of view?” we found:

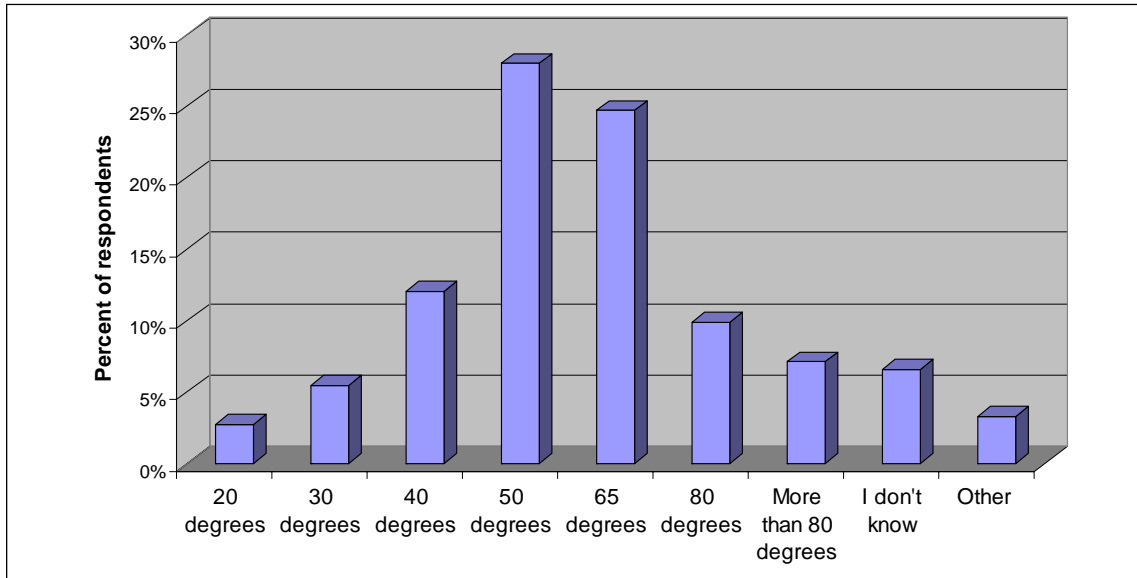


Figure 10 - 'good enough' vertical field of view

Similar to our findings on the horizontal field of view, most HMD products on the market offer a vertical field of view of 30 degrees or lower. This is found to be 'good enough' by just 8% of respondents.

Binocular overlap is also important in HMD applications that require a good sense of stereo. When asked about 'good enough' binocular overlap, we received:

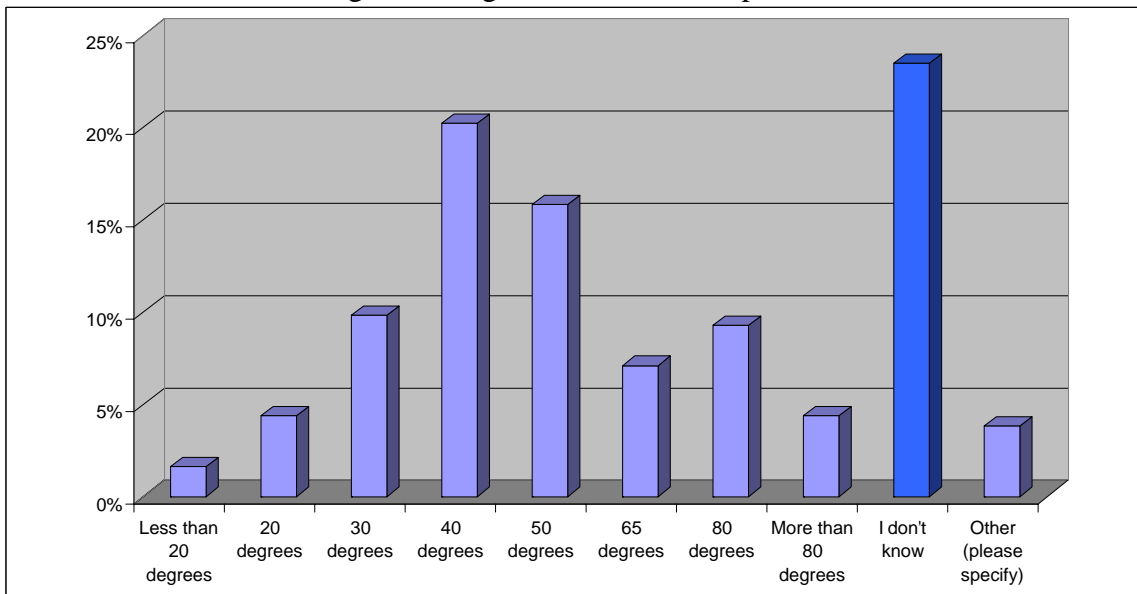


Figure 11 - 'good enough' binocular overlap

It was interesting to note that 23% responded “I don't know” to this question, indicating that market education is still required to help grasp the importance of binocular overlap.

Last, we asked about ‘good enough’ weight for the head-mounted display. The results were:

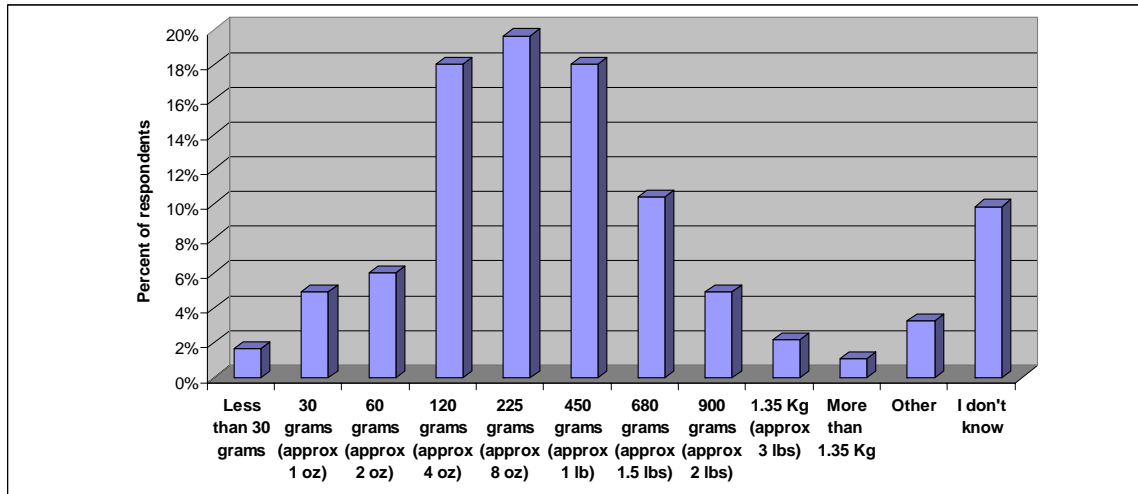


Figure 12 - ‘good enough’ weight

Discussion

There are numerous advantages to using a good HMD, when one is found: complete immersion, portable design, strong stereoscopy, accurate tracking, personal experience and more. However, many users routinely complain that most HMDs on the market today don’t fulfill that promise and suffer from tunnel vision, low resolution, front-heavy design, or other limitations.

These sentiments are indeed reflected in our survey results. Though nearly 95% of participants have used HMDs in the past, less than half are regularly using them today. Most report overall performance as a major concern in their historical decisions not to adopt HMD technology.

There are various performance parameters: horizontal and vertical field of view, binocular overlap, resolution, weight, convenience of use, upgradeability, robustness and more. Different applications have different sets of critical requirements, and this survey only presents the aggregate requirement set averaged across applications, geographies, and industries. However, in analyzing the survey results and in follow-on conversations, it became clear that some of these performance parameters are not well understood. For instance, customers may ask for “1680 x 1050” pixels per eye, whereas specifying the number of pixels per degree may be just as relevant, if not more.

Clearly, the fact that users don’t consider most current HMDs to be ‘good enough’ does not mean there is no current market for HMDs. With all their limitations, HMDs can still be considered the best solution for many existing projects.

However, hope is not lost. The arrival of new HMD products like the Sensics piSight allows meeting many of the desired performance criteria. We believe that with continued product development, widespread adoption of HMD technology will follow.



About Sensics

Sensics, Inc., the panoramic head-mounted display company, offers a comprehensive line of wide field-of-view, upgradeable, high-resolution head-mounted displays. Sensics products are used across the world by customers and leading solution providers to enable new and improved virtual reality applications for training, virtual prototyping, visualization and remote presence. Sensics is headquartered in Baltimore, Maryland.

The company's flagship product, the Sensics piSight™ line of panoramic, high-resolution, upgradeable HMDs offer substantial benefits over alternative HMD solutions:

- Dramatically larger field of view. By delivering imagery in the peripheral vision area, the piSight enhances situational awareness and provides a natural-feeling experience without unnecessary head movements.
- Higher resolution. High resolution throughout the visual field (20 pixels/degree, up to 10 million pixels per eye) increases realism and heightens the sense of immersion.
- Larger binocular (stereo) overlap. The piSight's large stereoscopic overlap – up to 84 degrees - enhances the perception of depth and simplifies the exploration and manipulation of near-field items.
- Upgradeability. The upgradeable piSight design mitigates the risk of "technology dead end" once the field of view or resolution needs exceed the performance delivered by the existing product.
- Superior display quality. Unlike traditional LCOS chips, The OLED display in the piSight don't smear when images change rapidly, provide high-contrast, are power efficient, yet require no backlight.

To learn more about the Sensics products or schedule a demo, contact us at:

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