

Augmented Reality Smart Glasses

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ABSTRACT: Augmented reality basically means the overlaying of virtual information on the real world-view. Applying this concept using smart glasses – wearable computer glasses that adds information to anything that the wearer sees has made this technology, i.e. Augmented Reality Smart Glasses (ARSG), increasingly popular. It has been identified as a vital technology supporting shop-floor operators in the smart factories of the future, gait-aid glasses for Parkinsons disease patients, guiding glasses for visually impaired people in the indoor environment. This paper aims at analysing the different kinds of ARSG products available in the market and enhance the usage of the same for various industrial purposes, such as by the manufacturing industry. The market for ARSG has grown to quite an extent in the recent years, and the large variety of products to select from makes it not only difficult but also time consuming to identify the best alternative. To address this problem, this paper presents an efficient step-by-step process for evaluating the ARSG, including concrete guidelines as to what parameters to consider and their recommended minimum values. This paper demonstrates the evaluation process in practice, presenting a comprehensive review of currently available products along with a recommended best buy.

KEYWORDS: Augmented reality, Smart glasses, Augmented reality smart glasses, Smart factory, Shop floor, Industrial operators

I. INTRODUCTION

Augmented Reality is a technology that superimposes a computer-generated image on a user's view of the real world, thus providing a composite view. It is a direct or indirect live view of a physical, real-world environment whose elements are "augmented" by computer-generated perceptual information, ideally across multiple sensory modalities, such as visual, auditory. In this way, augmented reality alters one's current perception of a real world environment, whereas virtual reality replaces the real world environment with a simulated one. The primary value of augmented reality is that it brings components of the digital world into a person's perception of the real world, and does so not as a simple display of data, but through the integration of immersive sensations that are perceived as natural parts of an environment.

Smart glasses are wearable computer glasses that add information alongside or to whatever the wearer sees. They can also be defined as computer glasses that are able to change their optical properties at runtime. Superimposing information onto a field of view is achieved through an optical head-mounted display or embedded wireless glasses with up display (HUD) or augmented reality overlay that has the capability of reflecting projected digital images as well as allowing the user to see through it, or see better with it.

A **smart factory** can be defined as a fully-integrated, collaborative manufacturing system that employs computer controls, modelling, big data and other automation to improve manufacturing efficiencies. They respond in real time via an open infrastructure that allows solutions to be implemented at the speed of business while creating advantaged value to meet changing demands and conditions in the factory, in the supply network and in customer needs.

Purpose of the topic chosen :

- **Enabling faster output by the smart factories** - A smart factory should always be robust and its machinery and equipment should be able to improve its manufacturing processes through automation and self-optimization. It uses a constant stream of data from connected operations and production system to learn and

adapt to new demands. For providing faster output, augmented reality smart glasses are the best knowhow to be used as per the current scenarios.

- **Guidelines to choose from the range of available products** -The huge variety of products available in the market makes it very difficult and time-consuming as well as tricky to choose the best alternative for a particular factory. Also the companies wouldn't totally know what are the parameters to be kept in mind while selecting from this large variety of products available.
- **How this will be useful to the manufacturing companies?** - This topic has been chosen in order to provide a step-by-step solution for evaluating the ARSG products. It would be very beneficial for the manufacturing companies as they can quickly compare the products available and make optimal decisions about what products to implement on their shop floors.

II. RELATED WORK

The concept of augmented reality was introduced in 1992 to denote a head-up, see-through display that Caudel and Mizell had designed as part of a research project. They described the concept as follows –“This technology is used to ‘augment’ the visual-field of the user with information necessary in the performance of the current task, and therefore we refer to the technology as AugmentedReality."Augmented reality and virtual reality have exploded for \$1.1 billion in investment this year and it's still considered the origins of the future of computing. Throughout the 20th century, AR developed into the refined technology that it is today. Augmented reality can be considered as a system having three characteristics: (a) the ability to combine real and virtual objects, (b) the ability to be interactive in real time, and (c) the ability to use 3D objects. It should be noted that augmented reality includes more senses than just the visual, potentially applying to all senses, including hearing, touch, and smell. [1]

• Implementation of AR

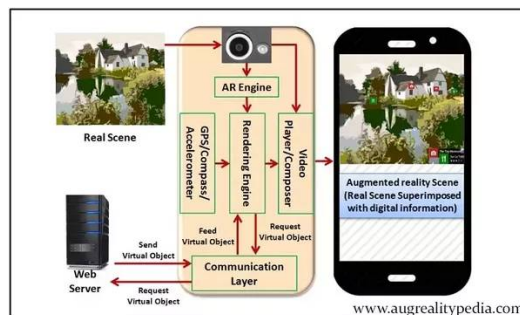


Fig. 1

The implementation of augmented reality is generally based on some form of real-world anchor used for navigation and to provide context-based information to the user. To enable the user to see the virtual objects and interact with the system, some sort of hardware device is used. There are three categories of such devices : (a) head-worn devices, (b) hand-held devices, and (c) spatial devices.

1. **Head-worn devices** : Visual displays attached to the head include the video/optical see-through head-mounted display (HMD), virtual retinal display (VRD), and head-mounted projective display (HMPD). A current drawback of head-worn displays is the fact that they have to connect to graphics computers like laptops that restrict mobility due to limited battery life.
2. **Hand-held devices** : This category includes hand-held video/optical see-through displays as well as hand-held projectors. Although this category of displays is bulkier than head-worn displays, it is currently the best work-around to introduce AR to a mass market due to low production costs and ease of use.
3. **Spatial devices** : The last category of displays are placed statically within the environment and include screen-based video see-through displays, spatial optical see-through displays, and projective displays. These techniques lend themselves well for large presentations and exhibitions with limited interaction. These devices

implement one of the following types of optics to visualize information to the user – video, optical, retinal, hologram or projection. [2]

III. METHODOLOGIES

The below figure shows how the algorithm works. In computer vision, speeded up robust features (SURF) is a patented local feature detector and descriptor. It can be used for tasks such as object recognition, image registration, classification or 3D reconstruction. To detect interest points, SURF uses an integer approximation of the determinant of Hessian blob detector, which can be computed with 3 integer operations using a precomputed integral image. The Surf algorithm has three main parts: interest point detection, local neighborhood description and matching.

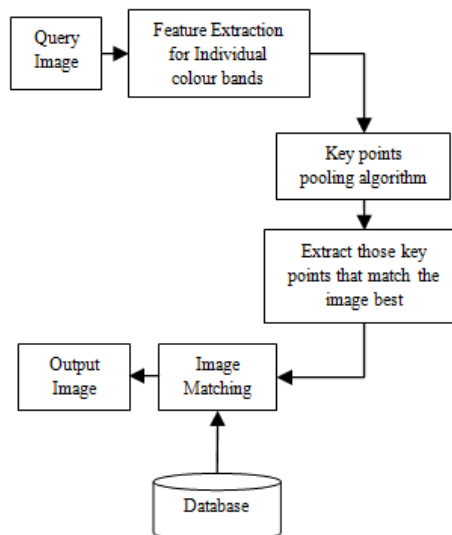


Fig. 2

- **Guidelines for selecting ARSG :**

1. Create a list including all products that fit the purchasing budget - The first thing to do is to find out how much money is budgeted for a pair of ARSG. To determine the maximum cost per pair of glasses, count how many operators on the shop-floor will use glasses simultaneously, and then add 10-20% to that number to provide spares in case of breakage. The purchasing budget is then divided by the number of glasses needed, giving the upper cost limit per pair of glasses. Now identify all products available on the market that fit the budget.
 - a) **Shorten the list by eliminating obviously unsuitable products** -When the list of potential products is complete, the next step is to evaluate these products based on a few critical parameters. The aim of doing this is to quickly narrow down the list so as not to waste time comprehensively evaluating products that are ultimately not of interest. We have identified the parameters specifically relevant to an industrial shop-floor that should be evaluated in this step: (1) powering, (2) weight, (3) field of view, (4) battery life, and (5) optics. *Powering* - ARSG can be powered in two ways, through either a battery pack or an ordinary computer. For the industrial shop-floor, battery power is essential as it is impossible for an operator to carry a computer throughout the workday (or even for shorter periods).
 - b) *Weight* - Since ARSG are meant to be worn more or less the whole day by operators, their weight is critical. To be realistic, we set the recommended upper limit to 100 grams (about five

times the weight of normal glasses) to allow most users to wear the glasses for at least a few hours.

- c) *Field of View* - The field of view denotes the area in which virtual objects can be seen via the ARSG. It is a crucial parameter as it directly affects how much information can be shown to the user and where it can be placed. The horizontal field of view is especially important, as a large horizontal field of view makes it possible to display information on the periphery, keeping the center of view clear for seeing the real world.
 - d) *Battery Life* - An operator on the industrial shop-floor is supposed to wear ARSG more or less throughout the working day and a durable battery is necessary to enable this. For integrated batteries, the battery life must be at least nine hours, or if fast charging is possible, four hours. For non-integrated batteries that can be hot-swapped, the battery life should be at least two hours.
 - e) *Optics* - Three types of optics can be implemented in ARSG for visualizing information: video, optical, and retinal projection. For the industrial shop-floor, a product that implements either an optical or a retina-based solution should be selected and video-based solutions should be avoided.
2. **Make a comprehensive evaluation of all remaining products and select the best one** - The remaining products are evaluated based on the following parameters : Price, Powering, Weight, Field of view, Battery life, Optics, Camera, Open API, Audio, Sensors, Control, Processors, Storage, Memory, Connectivity, Operating system, Durable against dust, Durable against water.

IV. EXPERIMENTAL RESULTS

- **Review of Augmented Reality Smart Glasses currently available in the market**

The research method chosen for the product evaluation is that of a systematic review, which defines a structured process for identifying and analyzing ARSG from multiple sources. The systematic review performed here follows the five standard phases described, as follows:

1. **DEFINE A QUESTION** - The question to be answered by this review is: Which of the ARSG available on the market is best suited to the industrial shop-floor? This question is formulated in line with the overall purpose of the paper, to provide the manufacturing industry with recommendations as to the choice of ARSG to adopt on the shop -floors.
2. **IDENTIFY RELEVANT ARTIFACTS** - In a systematic review, the artifacts to be studied should match certain explicit criteria. In this case, the following three keywords were used as matching criteria in searching for products: smart glasses, augmented reality glasses, augmented reality head-up display. The keywords were used separately, that is, matching one criterion (i.e., keyword) was enough for a product to be included in the review.
3. **ASSESS THE QUALITY OF THE ARTIFACTS** - The relevant products identified were assessed based on the parameters already discussed. Technical specifications and information on vendor websites were the main sources of information. In cases in which information for answering a specific question was missing, the vendor was contacted and asked for information.
4. **SUMMARIZE THE FINDINGS** - The parameter values of all products were compiled into tables to give a convenient overview and facilitate easy comparison.
5. **INTERPRET THE FINDINGS** - In this last step of the systematic review, the products were carefully analyzed and their strengths and weaknesses concerning industrial shop-floor application were identified. Based on the findings, recommendations were formulated for the industry.



Fig. 3(a)

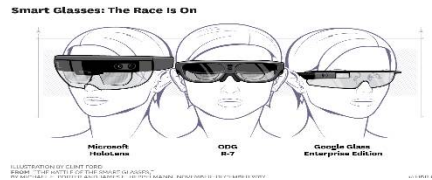


Fig. 3(b)



Fig. 3(c)

Augmented Reality – Enhancing our Experiences



New situational awareness experiences

- **Augmented reality (AR)** is a live, direct or indirect, view of a physical, real-world environment whose elements are augmented by computer-generated sensory input such as sound, video, graphics or GPS data.
- Not to be confused with **virtual reality** – which replaces a real world with a simulated one.

Purpose: Understand how AR may Benefit the Digital Worker
1) Real Examples, 2) Research Questions, 3) Opportunities

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Fig. 3(d)

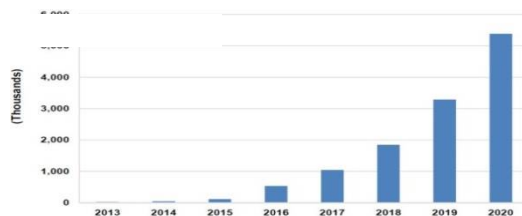


Fig.3(e)

These figures show the results of Augmented Reality Smart Glasses. Fig 3(a) shows the original image of how the ARSG used to look, how they look now and how they will look like in the future, 3(b) shows different models of ARSG worn by a person, 3(c) shows the different ARSG products available in the market, 3(d) shows how AR works in real life scenarios and 3(e) shows the changing trend of AR over the years.

V. CONCLUSION

The aim of this paper is to take the manufacturing industry one step closer to the broad adoption of ARSG by improving our knowledge of how to efficiently evaluate and select such glasses for the industrial shop-floor. The review demonstrates that many sophisticated products are available on the market today, but that they are remarkably heterogeneous. The suggested evaluation process is clearly needed, since assessing the products and identifying the best buy for the industrial shop-floor are non-trivial tasks in the absence of supporting guidelines. Of the currently available products, the study recommends that Epson-Moverio BT-300 seems to be the best general choice for the industrial shop-floor. This product is the only one that makes it through the whole evaluation process and fulfils all basic requirements.

Future enhancements that can be done on this idea are :

1. Extending the field of view
2. Making the glasses wearable
3. Developing guidelines for user interface design

4. Enabling benchmark evaluation
5. Improving voice-based interaction in noisy environments -

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