

Smart Vision: Features, Applications, Current Progress and Challenges

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Abstract :- Among the recent inventions, smart glass is one of the wearable device typically referred to be switchable glass that is capable of handling a wide range of computing activities that an ordinary human cannot do. It is the amalgamation of technologies that help in converting the transparent nature of the hard glass into the translucent mostly allowing the human to machine interactions. In this paper, insights into the smart glass and its design factors were highlighted. Moreover, its features and various commercially available smart glasses were carefully studied. Besides these, a survey on smart glass applications is made, and various possible new applications were explored. Unlike the possible applications, numerous challenges faced by the smart glasses were explored.

Keyword's: Smart glass, wearable technology, head-mounted displays, wearable device, switchable glass, augmented reality, applications of smart glasses, virtual reality, smart glass applications, smart glass features, challenges in the smart glass, smart glass design factors.

1. INTRODUCTION:

Research on developing smart technology is taking its boom in recent years making the efforts towards enhanced human life. Potential contributions were reported in the literature on the smart technology developmental activities. Smart technology typically refers to the use of information and communication technology in parallel to the hardware components [1-3]. Among the available smart technologies, the most popular ones are a smart-watch, smart glass, smart jacket, smart fabric, smart fashion, smart gaming devices etc. [4]. Wearable smart technologies were recently expanded into many areas, especially the industrial, gaming, and medical sectors in solving issues. The reason for this is the need for active data collection, processing, decision making in executing the task [5]. As a part of this, machine to machine (M-M), human to machine (H-M) interactions became more popular by overthrowing the human to human (H-H) interactions.

When we see these three interactions, i.e. M-M, H-M, and H-H, we find many differences in the use of technology to achieve the objective, use cases, and product development. In M-M, the interactions will happen between two or more machines mostly eliminate the need for humanitarian

interventions. Mostly, this would happen with the digital and autonomous controlled devices or products. In H-M, the interactions will happen between the human to machines, allowing the human workforce to deliver some instructions in carrying out the task. Whereas in the case of H-H, all the instructions are possible between the workforce. Among the three, the most adopted one in present scenarios is the H-M. With this, research on developing the products and services, exploration and adoption of its use related to the human to machine interactions were being carried out [6].

Hence, studying the concepts like communication technologies, information technologies, and their associated technologies possible in human to machine interactions are more important. Smart and wearable devices like smart glasses which relate to the above fields can be given more importance. As per the understanding, they seem to have special features that would help in improving the human workforce capabilities. But how far the use of smart glasses would be, where and in which sector these smart glasses can better fit etc. were still being explored.

The study presented in this paper focuses on the insights into the smart glass with a concentration made on the available commercial smart glasses, design factors on smart glass, features, applications, progress and the challenges. In short, this study aims to explore the applications and challenges of augmented reality based smart glass

II. INSIGHTS INTO SMART GLASS

Smart glasses come under the smart device category mostly used for handling the tasks related to human to machine interactions. Here, in this section, the insights into the smart glasses were explored concentrating on smart glass products, smart glass components, embedded technologies, and design factors.



Fig. 1. Smart glass indicating its features [7] (Source: Smart Vision Labs).

1. Smart Glass and Its Components

Smart glass is one of the types under the head-mounted displays (HMD's). Smart glass is a smart wearable device that brings up the wearers, computing facilities, and clients together for handling the most complex task in a simple manner [8]. With smart glasses, the available information at the work site is easily transferred to the controlling and central or distributed monitoring stations. The process of information exchange, information sharing is done very quickly and even can be stored for future reference. Fig. 1. [7] Shows a typical smart glass along with its features. As per the smart glass is shown in Fig. 1., it has features like Bluetooth, focus camera, onboard battery power, memory storage device, photo and video viewer display, microphone, magnetometer, GPS etc. [9-11].

and long run life, the smart glasses must be designed effectively [14].

During the process of manufacturing or fabrication, in every step reliability and durability issues.

Most important design factors that need to be concentrated during the design and fabrication process are aesthetic look, battery life, compatibility, compactness, data security, design frame, durability, dustproof, ergonomics, field view, hands-free, powering, privacy, reliability, voice control, weight, waterproof. Below sub-sections will give brief about design factors and the need for consideration.

1. Aesthetic look: Look, and finishing of the product is more essential as it also one of the parameters that influence the product market. Hence, the look of the product is to be considered while designing.

2. Battery life: Most smart glasses were used by the operators in the daytime or in the usual working time. Hence, the battery should be able to handle the required tasks, and it would be even better if battery autonomy is considered during the design [16].

3. Compatibility: This would be an issue while connecting the smart glass to a network. Hence, the designer should or developed smart glass should

4. Compactness: In some cases compact compactness is more important because the size of the product should be small in certain applications. Hence,

TABLE I. LIST OF AVAILABLE WEARABLE SMART GLASSES

Make	Smart Glass	Features	Display	Interface	Ref.
EmoPulse	EmoPulse nano Glass 4	Visual Alert Notification	Fibre-optic Color LEDs	Phone, Touch	[11, 12]
GlassUp	GlassUp AR Glasses	Augmented Reality, Projector	320x240 Proprietary	Phone, Touch	[11, 12]
Google	Google Glass	Augmented Reality	640×360 Himax LCoS Display	Phone, Touch, Voice	[10-12]
Meta	Meta AR Glasses	Augmented Reality	960x540 (qHD) 16:9 Display	Windows	[11, 12]
Microsoft	Microsoft HoloLens	Augmented Reality	~1,000x500; ~30° x 17.5°	Windows	[11, 12]
Samsung	Samsung Smart Glasses Hybrid	Augmented Reality	Dual Display	Touch, Voice	[11, 12]
Sony	Sony Smart Eye Glass	Augmented Reality	419x138 8-bit Green Display	Wired Controller	[11, 12]

Like the smartphones, the smart glasses are also having few components, namely: "liquid crystal displays (LCD) or light emitting diode (LED) displays, optical lenses, electrochromic, suspended particles, optical head-mounted displays, thermochromic, multiple sensors, photochromic, and processing capability handlers" [10, 13]. The market available and yet to be released smart glasses were briefly highlighted in the TABLE I. Various components present in the smart glasses and its features were shown in TABLE II.

B. Design Factors

The smart glass product quality is strongly depending on the many things that are embedded in it. To have the best quality

more compact product among the same kind is more advisable.

5. Data security: This should be considered as one of the major design factors. In most cases, the on-site information from the wearer is to send to the central server. During this situation, there might raise the issues of data loss etc. Enabling the Blockchain technology features or distributed computing networks with the smart glass would be much better.

6. Design frame: All the operators head mounting requirements may not be the same. Some operators may require small size design frame to have a better fit. So it would be better to have different sizes of smart glass frame designs.

TABLE II. COMPONENTS PRESENT IN A TYPICAL SMART GLASS

Smart Glass Components [10]	Features
Accelerometer	It measures the speed of the rotation keeping the rest position of the frame as a reference.
Ambient light sensor	This will enhance the visual display quality by providing brightness.
Battery	Helps in powering the smart glass and its components which needs to the power supply.
Camera	It captures the videos, images with the help of wearer instructions.
Connectivity	Helps in connecting the smart glass with another network using Wi-Fi, Bluetooth, USB.
Controls	This helps in the control of various sensors and other components.
GPS	Helps in identifying the wearer's location including the history and suggested travel route as well as standstill position.
Gyroscopic sensors	Helps in identifying the orientation of the smart glass wearer concerning the reference axis.
Magnetometer	Acts as a supporting tool in the navigation services in the smart glass.
Memory unit	Helps in storing the information that includes images, videos, text files, voice commands etc.
Microphone	Helps in the giving the voice commands or voice instructions.
Optic lenses	Acts as a supporting system for the camera with a unique feature, i.e. field view of the capturing area.

7. **Durability:** As these smart glasses were meant to operate in varying environmental situations. Few cases like, during the industrial operations like petrochemicals, processing, iron and steel etc., the environmental conditions would be bit severe, but in the monitoring, the workforce, medical field, education etc., the environment would be better. However irrespective of the environmental conditions, the lifespan or durability of the smart glass should be higher. Hence, the fabricator should take this durability factor as one of serious one during the design of smart glass.

8. **Dustproof:** Possibility of occurring dust events is more at the on-site industrial operations. Hence, there is a need for designing the dustproof smart glass. Also, the wearer keeps the smart glass at his head position, so the dust events cause problems to the human eye [15, 16].

9. **Ergonomics:** Situations of usability issues would arise for every product, and the same is possible in the case of smart glass. Hence, the designer has to take ergonomics of the smart glass during the early stages itself [15].

10. **Field view:** The present available or the latest and upcoming one is capable of having optical lenses where they have enabled with a unique feature called the field of capture. For most smart glass field view is lesser.

Hence, the designer should carefully think to extend the possibility of field view capturing area.

11. **Hands-free:** In most cases, the wearers would like to have the hand free control over the smart glass. Likely, the wearer's hand would be busy in fixing and operating the industrial tasks at the on-site. Hence, the wearers would require to have completely hand free controlled smart glass.

12. **Powering:** Power source is an essential one in the smart glass. A careful study has to be taken on the power usage estimations as per the wearer's operations and make sure that suitable and lightweight and reliable power source can be fitted into it.

13. **Privacy:** In the electronic gadgets, the problem of interference due to other devices is possible. For suppose during the workplace, wearers smart glass can interact with any of the systems that are operating in that area. Hence, the designer should carefully consider the privacy issues.

14. **Reliability:** The smart glass is not an individual component. Instead, it is an amalgamation of various sensors, communication devices etc. Hence every component has its issues and reasons for failure. Due to this reasons, while the design of smart glass, the fabricators should consider the reliability issues.

15. **Voice control:** As these smart glasses were meant to be operated with the wearer's instructions, the voice control option and its allied services should be good [15].

16. **Weight:** One of the most critical factors to be considered, as the weight of the smart glass increases, it has more burden on the wearer. This is because the wearer has to wear the smart glass on to a head for long hours typically 8-12 hours in most industrial operations. Hence, make sure that smart glass would have an optimum weight [16].

17. **Waterproof:** While designing, the manufacturer or fabricator should consider possibilities of water influenced damage during the usage. Most cases, the industrial operations would experience too much moisture, water flushing jets etc. Hence, the designed smart glasses should be waterproof [16].

III. FEATURES OF SMART GLASS

Like the smartphones, the newly emerged smart glasses also have many features. These features mainly favour the industrial operations, education services, medical services etc. Features include the voice recording, text preparation, video recording, location services, data exchange, augmented reality (AR), virtual reality (VR), and mixed reality (MR) etc. Fig. 2, shows the possible features of a typical smart glass available in the market.

The possible optical features of the wearable smart glasses to experience the augmented reality [16]:

- Virtual worlds and real worlds experiences would appear in the same line or view giving a fully digital experience to the wearer.
- Due to optical elements, the objects seen in virtual worlds appear to be overlapped in a

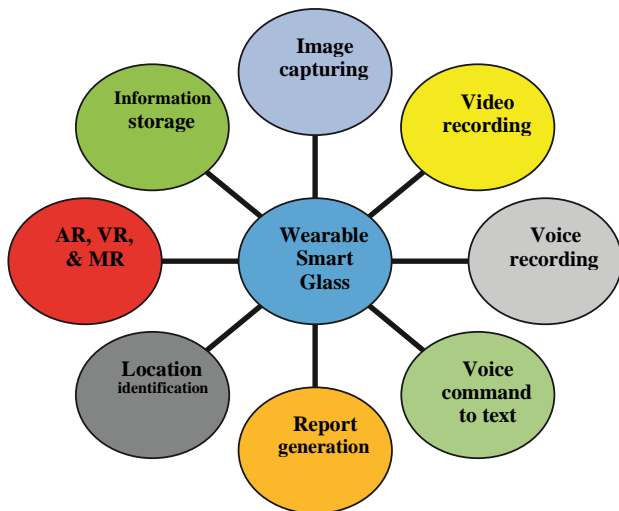


Fig. 2. Wearable smart glass features.

straight line on to the view of the real world objects.

- With the help of low power laser light, there is a possibility of projecting the virtual worlds objects straight away onto the retina.
- The photometric emulsion can be sued to show the virtual worlds objects in the real world.

IV. APPLICATIONS OF SMART GLASSES

Among all the available wearable devices, smart glasses have emerged into many sectors finding its applicability and scope for solving real-time problems. Few applications were explored and discussed below:

A. Aerospace and Avionics

In aerospace and avionics industry, the use of eyewear and optical head-mounted displays would become very useful.

Here, most sophisticated, nano and micro level operation and maintenance are possible. Virtual instructions can be given very easily with the help of smart glasses.

B. Atmospheric Study

With the help of smart glasses, the wearer can study the visual patterns of the atmospheric things. Can identify the parameters that influence the environment

C. Cement, Chemicals and Fertilizer

Smart glasses enabled with thermal cameras and few harmful gasses sensing elements can be applied in the cement, chemical, and fertiliser industries. Using thermal imaging cameras, the wearer can study the heat distributions and their patterns at various points.

D. Documentations

Smart glasses with voice-enabled features helps in preparing the documentation on the site itself during the inspection. With the help of cameras, the wearer can even draft an e-copy of the report using the on-site captured images [17].

E. Food and Agricultural Sector

Smart glasses can play a vital role in the food and agricultural sector. Scanning of packed food bags, quality check of the Agri-products, vegetables, live to monitor of Agri crops health etc.

F. Gaming

Augmented reality and virtual reality feature of the smart glass and optical head-mounted displays will help in living the game experience.

G. Education

In the education sector, smart glasses help with telementoring, virtual tutoring, to understand listeners experience, document preparation, instant reference etc.[17, 18].

H. Entertainment

The entertainment sector includes movies, news, etc. In this case, the user can experience the entertainment as required for him in his or her preferences like colour adjustments, language change, voice-controlled movie experience [17].

I. Health Care and Medical

In healthcare and medical field, the smart glasses can be used in the surgery performing activity, helps in giving the voice-enabled instructions to the blind person, to refer to the case studies of the medical operation activities, it also helps the deaf persons in visualizing the subtitles of the instructions in wearers interest [17, 18].

J. Industrial On-site and Off-site

Smart glasses, head mounted display with their computing capabilities can perform intelligent on-site and off-site operations. For example, in the telecom sectors tower construction instructions etc.

K. Electrical Power System

Acts as an intelligent reference guide in collecting the circuit and troubleshooting information of the component in the electrical power system. Also, enables video and audiobased instruction for operation and maintenance [10,11].

L. Solar Power Plant Operations

In solar power plant operation and maintenance, smart glasses and optical head-mounted displays help in addressing the dust issues, the temperature distribution on the module, moisture content on the PV module using the camera and optical devices. Also, helps in identifying the cracks on the PV module, ice effect etc. [10, 11]

M. Wind Power Plant Operations

In wind power plants, smart glasses help in detecting the damages in the wind blades, wind towers, the effect of ice, cracks at various points [11].

N. Commerce

Smart glasses with its features can play even play a smart role in the commerce industry. In many commerce industry, the smart glasses can be implemented for identifying the employee identity. This will act as the best authenticating device and takes very less to verify the candidature. For example, with the help of smart glasses, the wearer can control the visuals played in the video billboard present in the advertising areas. Can even post the live feedback of the product with both audio and video visionary [17].

O. Remote Control Operations

In many sectors, the remote control operations can be enabled with the special features of the smart glasses. The special features that help in remote monitoring are voiceenabled commands, report generation, visual imaginary, location detection etc.

P. Waste Management and Municipal Operations

In the municipal waste management department, the smart glasses can be used for segregating the various types of waste generation. In this situation, the smart glass features like image capturing and analysis could help. One can even identify the harmful wastes.

Q. Warehouse Goods Management

In the warehouse, the number of good that would flow is very huge. In such cases, the manual operation of counting and scanning would be complicated. Here, the smart glasses can be used to scan the products in the warehouse. This makes the work more comfortable and fast.

R. Traffic Crime Detection Management

With the help of smart glass and optical head-mounted displays, the traffic in charge can record the incidents that happen on the roads. In the later stages, the incidents can further analysis to detect the what exactly happened.

S. Security Check Record Maintenance

With the help of smart glasses, the security check process can be simplified during the identity verification process. The feature of augmented and virtual reality can enable the existed identical features with the real-time options.

With this process of identification will happen more securely. With the integration of blockchain enabled smart glass, the process of verification would even be more secure [19].

T. Navigation and Travel Experience

With the help of a smart glass, the navigation experience can be improved. One can easily identify the location maps, finding shortest and safe ways. With the integration of traffic management systems with smart glass, the traveller can estimate and visualise the time required. The traveller can visualise the tourism places virtually before he visits the actual places [10, 11, 17].

V. PROGRESS AND CHALLENGES IN SMART GLASSES*A. Progress in Wearable Smart Glasses*

Wearable smart glasses are becoming popular day by day giving the scope for the new developments, additional features, compact sized, multi-functional devices, specific designs depending on the type of industrial work, smart glass for smart factories etc. Only a few products have been released into the markets, but some have been stopped. The reasons for it must explore. However, the research aspects in the smart glasses are continuing, but the industrial usage or the application side is quite less, and it has not become that trending. Also, there are few limitations to the current smart glasses; these include the computing capabilities like facial recognition, pattern recognition, and image processing. Apart from this, in the present available smart glasses, the power source is quite less, and it may not be sufficient for some energy-intensive tasks. Hence the power source can be improved.

B. Challenges in Smart Glasses

Few challenges are possible with the smart glasses, and these are discussed below [11, 20, 21]:

- Challenge occurs mainly during the visual inspection as the wearer of the smart glass need to collaborate on a live video with the centralised control team located in different places.
- Lack of strong network security and robust wired or Wi-Fi connectivity Bandwidth.
- Possible interruptions during the communication between wearer and control person. Chances are more while delivering the augmented reality services.
- Lack of augmented reality content, at present the content available in the old one and it is not suitable mostly. Hence the content must be reframed to experience the augmented reality.
- Smart glass safety issues to the wearer.
- Manufacturing of such highly sensitive gadget needs complex manufacturing.
- Privacy issues arise mostly interrupting the smart glass system; these occur by the influence of external devices that are connected to a network or sensitive towards electronic interference.
- Lack of strong regulations either from the manufacturer's side, government side, and from the user's side.
- Lack of use cases.
- Lack of strong public acceptance, and less awareness over the smart glass usage and development, and their application.
- As the smart glass involves many components and instruments, electronic and computer network interfacing devices, the wearer would feel difficulty.

VI. CONCLUSION

From this, it seems that wearable smart glass has good scope for the development as well as the contributions in many application areas. Here in this paper, the currently available smart glass along with their features, design factors, application and challenges were explored and discussed. Still, some more improvements were needed for the smart glass to make itself as the best fit in many potential areas. Apart from this, the skill gap, techno-economic gap between the smart glass manufacturers and users must be eliminated. Hence, the successful use of smart glasses should be demonstrated as it may encourage the other practisers to adopt the use of smart glass and get benefitted by with its features.

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