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INNOVATIONS IN AUGMENTED REALITY GLASSES: CHALLENGES AND OPPORTUNITIES

(BRIDGING SERVICE TECHNOLOGIES AND CONSUMER NEEDS IN THE AR OPTICS MARKET)

Summary. *Augmented reality (AR) technologies in personal and consumer optics are still in their infancy. Despite the high cost and limited comfort of current AR headsets, their integration into personal and public infrastructures suggests a promising future. This article explores the development of AR glasses and their associated service technologies, emphasizing the need for innovative technical solutions to meet market demands. Special attention is given to creating cleaning systems for AR optics using deionized water and developing comprehensive service technologies to ensure sustainable growth in the AR sector.*

Key words: *Augmented Reality, AR Glasses, optical technology, service innovation, consumer electronics, deionized water, optical cleaning solutions.*

Introduction. Augmented reality overlays virtual objects onto the real world, enhancing human perception through devices like AR browsers and glasses. While

these technologies have seen moderate success, the absence of user-friendly designs and robust service technologies hinders their widespread adoption. This paper proposes practical solutions for overcoming these challenges, focusing on the service and maintenance aspects of AR glasses.

Problem Statement. Despite technological advancements, AR glasses remain niche products, failing to achieve the ubiquity of smartphones or smartwatches. A critical issue is the lack of service technologies to support mass production and daily use. Current AR glasses struggle with practical concerns, such as cleaning lenses effectively and ensuring long-term user comfort and safety.

Objective. The study aims to explore and propose innovative service technologies for AR glasses, including cleaning solutions using deionized water, systems for optical maintenance, and frameworks for integrating these technologies into the consumer market.

Materials and Methods:

- **Materials:** Patents, market reports, and technical specifications of AR glasses.
- **Methods:** Analytical review, practical testing of cleaning solutions, and modeling service systems for AR devices.

Review of Recent Studies and Publications. Research highlights the potential of AR glasses in fields like gaming, healthcare, and engineering. However, few studies address the practical maintenance and service requirements for these devices. Patents reviewed by the author reveal significant gaps in the development of technical solutions for cleaning and servicing AR optics.

Augmented Reality Technologies in Everyday and Personal Optics: Challenges and Prospects

Augmented Reality (AR) technologies in personal and household optics are still in their infancy. However, considering their potential for horizontal and vertical

integration into personal and public infrastructure needs, these technologies are expected to have a bright future.

Currently, AR headsets, incorporating primary applications and combinations of these technologies, remain expensive and uncomfortable for all-day use. Despite these drawbacks, the anticipated surge in consumer interest compels a thorough analytical exploration of this topic.

One unresolved issue in the adoption of such technologies is the service and maintenance aspect. The author, drawing on experience in servicing various personal and household optical applications, offers several proposals and ideas to address this challenge.

Defining Augmented Reality

AR refers to technology that overlays virtual objects onto the real-world view as seen through the human eye. The most common household applications of AR are AR browsers and AR glasses. In AR browsers, virtual objects are superimposed onto images from smartphone or tablet cameras, while in AR glasses, the objects are displayed on the lens or a miniature monitor.

Experts continue to analyze the commercial potential of AR-based products, uncovering intriguing details that, when understood correctly, can help achieve positive results.

Challenges in AR Glasses Development

Since the release of the first relatively successful AR glasses project, significant time has passed, yet no optimal design for such glasses has emerged. Early AR glasses created excitement but failed to maintain user interest over time, as users struggled to integrate these devices into daily life as seamlessly as smartphones, gaming consoles, or smartwatches.

One key issue is the lack of adequate service technologies to support these complex devices in mass production and consumption.

Patents: A Barometer of Technological Interest

The state of patent protection in AR technologies reveals an unexpected lack of activity. Despite AR's potential to open new technological avenues and drive rapid sales growth when integrated with existing digital technologies, patent filings remain sparse. A patent search conducted by the author in the U.S. Patent Office yielded only 133 applications and no granted patents in this area:

- **Glasses of Additional Reality:** 113 patent applications
- **Visualization of Additional Reality:** 20 patent applications

An analysis of published applications suggests they are largely exploratory and do not focus on AR glasses as mature products. This points to a lack of experience in the servicing and operation of such devices.

Technical Gaps in Everyday AR Glasses Usage

Practical implementation of AR glasses in the market is hindered by the absence of supporting tools and solutions. One critical issue is the maintenance of AR glasses in everyday life, such as cleaning lenses of organic and inorganic contaminants. AR glasses lenses, like ordinary glasses, are prone to dirt, requiring innovative solutions.

The author highlights the need for a comprehensive cleaning and disinfecting technology that can produce solutions from low-mineral water, including the removal of hardness salts. This is an essential first step in developing practical AR glasses maintenance solutions.

By addressing these challenges, the AR industry can move closer to integrating these promising technologies into daily life, unlocking their full potential.

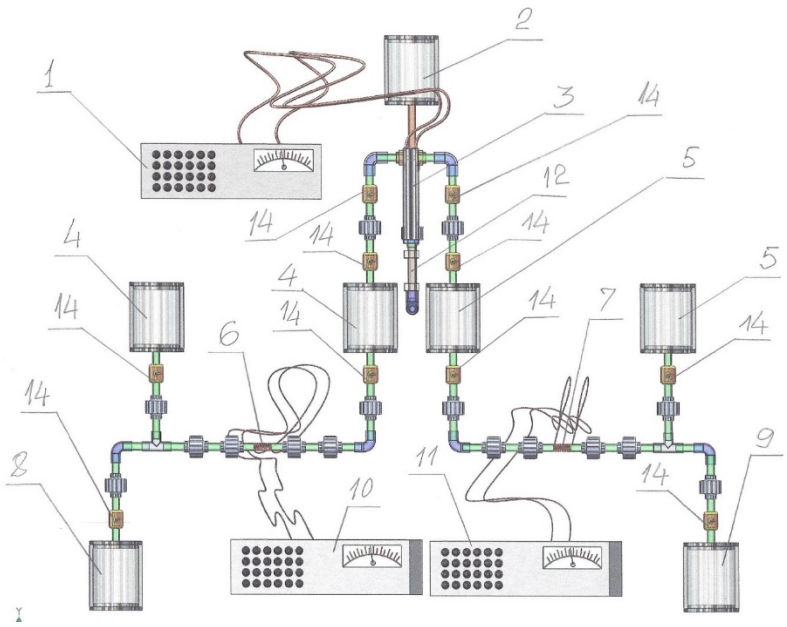

Fig. 1. System Model for Adjusting Acidity and Alkalinity in Deionized Water in Two Directions

1. **Power Source** for the electrochemical reactor.
2. **Container of Deionized Water** for feeding into the electrochemical reactor.
3. **Electrochemical Reactor** with an inter-electrode space where treatment occurs in two parallel upward flows.
4. **Water Collector** with reduced acidity levels.
5. **Water Collector** with increased alkalinity levels.
6. **Sensor Module** for measuring reduced acidity levels.
7. **Sensor Module** for measuring increased alkalinity levels.
8. **Reservoir** for water with reduced acidity levels.
9. **Reservoir** for water with increased alkalinity levels.
10. **Pulse Generator** for the impedance-resonance sensor.
11. **Pulse Generator** for the impedance-resonance sensor.

Despite these measures, reality demanded more: the cleaning liquid must act as an **insulator** to eliminate any possible local current impulses.

Source Analysis for Water Treatment in the System

Analysis of potential water sources for treatment led to a focus on photolithography production complexes, where deionized water is used. This water possesses properties closely aligned with those deemed most essential and suitable for servicing the optical lenses of augmented reality glasses.

For comparison, options using distilled water and highly purified water were also evaluated. However, the properties and qualities of deionized water proved to be superior.

Potential Future Applications

The feasibility of using deionized water — both before and after processing in the electrochemical reactor — for the preparation of various emulsions for augmented reality glasses servicing was also examined.

Experimental testing confirmed the ability to produce high-quality emulsions using deionized water both before treatment and after adjusting its acidity or alkalinity levels. These findings demonstrate the potential of deionized water as a versatile and effective component in the maintenance of advanced optical technologies.

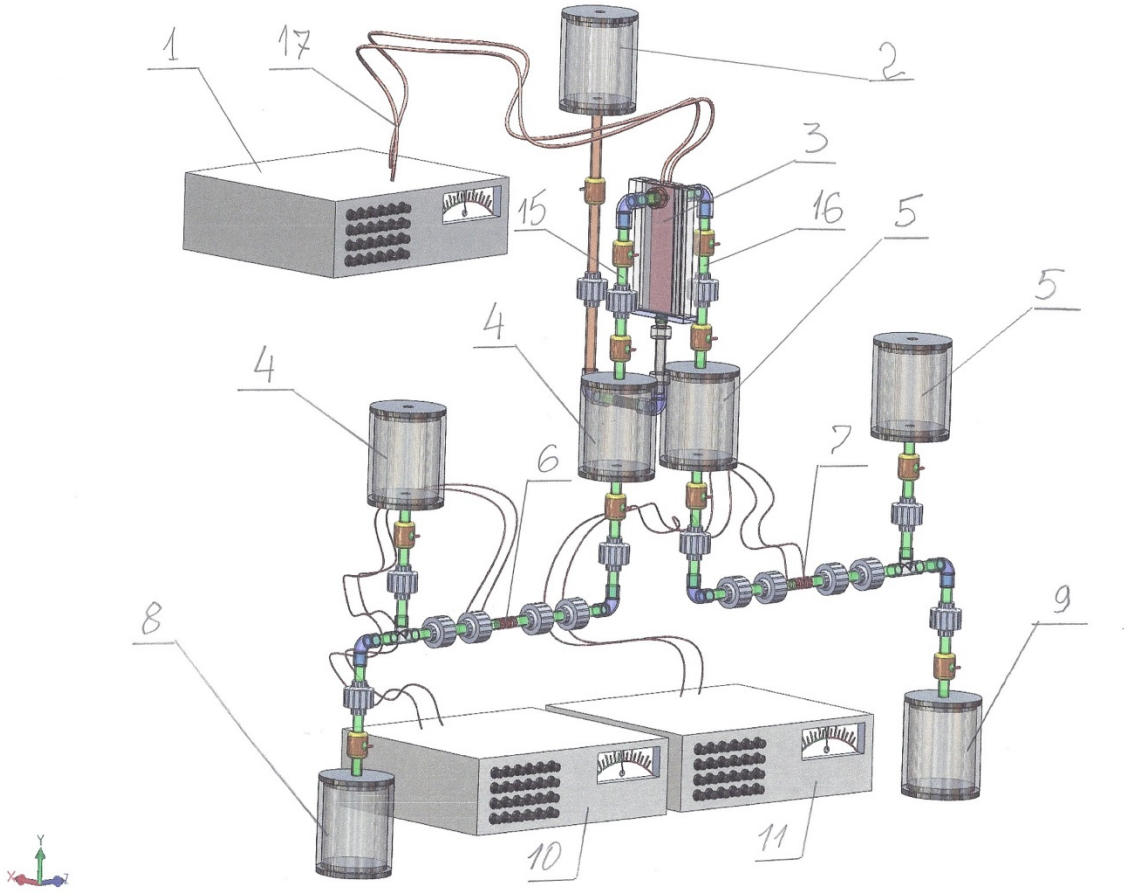

Fig. 2. System Model for Adjusting Acidity and Alkalinity in Deionized Water in Two Directions

12. **Inlet Pipeline** to the electrochemical reactor.
13. **Regulating and Control Valves.**

    15, 16. **Flowmeters.**
14. **Current-Carrying Cables.**

Selection and Analysis of Water Options

The selection and evaluation of various options ultimately demonstrated that the use of **deionized water** is the most suitable choice. Widely utilized in

microelectronics, deionized water is a standard component in photolithography technologies.

This type of water is produced in significant quantities and is relatively inexpensive, making it an ideal candidate for use in systems requiring precise adjustments to acidity and alkalinity.

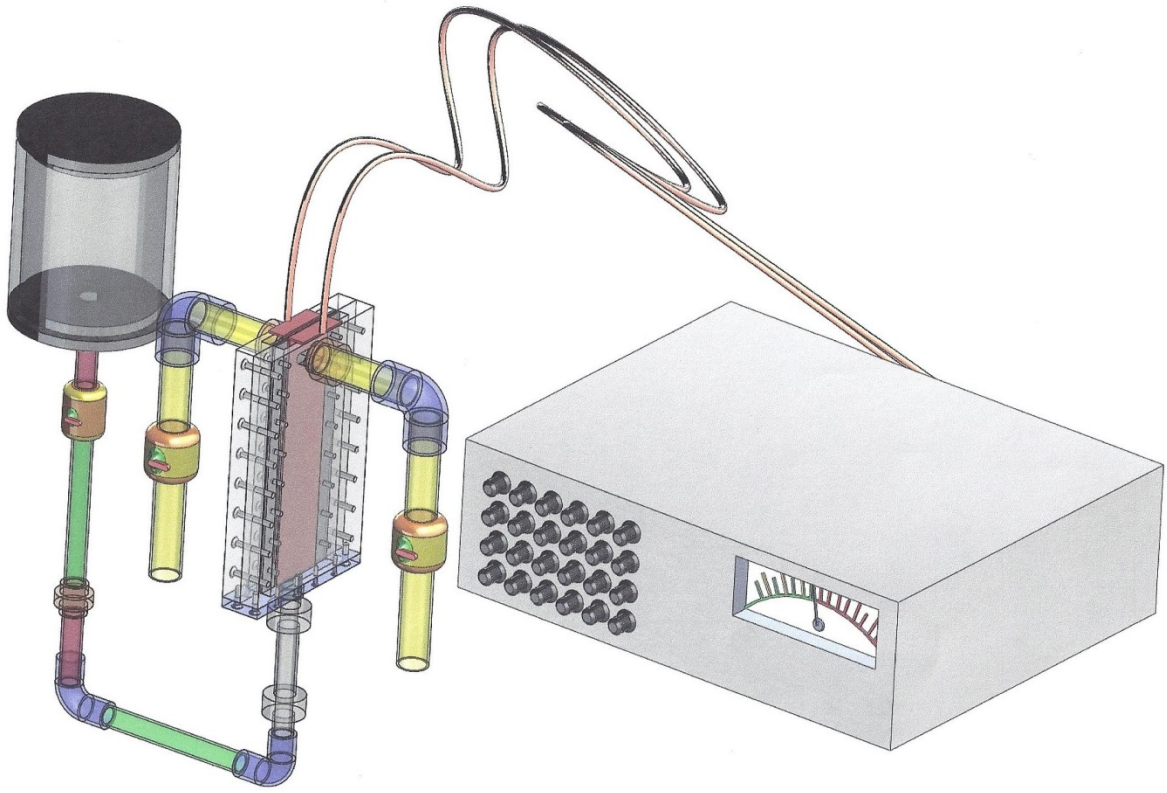

Fig. 3. Electrochemical Reactor Model with Power Source

Since this technology is being recommended for use for the first time, a basic prototype was created to test the feasibility of implementing several innovative technologies in real-world conditions. The first of these innovations is the design and functionality of the electrochemical reactor.

In the described reactor, the electrode cells have working zones separated by a neutral membrane symmetrically positioned between two electrodes. A key

operational principle is that deionized water is treated within a developed upward flow.

The distance between the working planes of the electrodes is only **3 millimeters**, with the membrane thickness being **1 millimeter**, leaving a liquid flow thickness of just **1 millimeter**.

This configuration allowed for a significant increase in current density, reaching **100 amperes per square decimeter**, enabling the electrochemical correction of acidity and alkalinity in water with properties very similar to those of a dielectric fluid.

Dual-Stream Output for Optical Cleaning

The system produces two output streams:

- **Alkaline water** for cleaning grease and oily contaminants.
- **Acidic water** for disinfecting optical surfaces by eliminating microorganisms and bacteria.

This dual functionality makes it particularly effective for cleaning the lenses of augmented reality glasses, as well as other optical devices.

Simple Design and Broad Applicability

The simplicity of the system design, which utilizes common structural materials and components from mechanical engineering, makes it feasible to install in small retail outlets selling optical instruments and glasses, including augmented reality glasses of current and future modifications.

Additional Feature: Anti-Allergenic Effect

A noteworthy characteristic of the system is its **anti-allergenic effect**, which is not limited to augmented reality glasses but applies to optical devices in general.

Since the reactor's power supply connects both the cathode and anode of the electrode cell from a single source, the acid and alkaline reactions occur proportionally at equivalent current densities. This proportionality ensures that

neither the acidic nor the alkaline output triggers allergic reactions when used simultaneously.

This phenomenon significantly enhances the consumer appeal of the system for a variety of optical applications.

Critical Importance of Electrode Cell Design

In systems designed for the dynamic electrochemical treatment of low-conductivity liquids, the electrode cell's construction is a decisive factor. This includes:

- Materials used for electrode fabrication.
- Design and composition of the neutral membrane.
- Materials and construction of the cell housing.

The application of **carbon-carbon composite electrodes** has shown particular potential for improving efficiency. This unique feature will be discussed in detail in subsequent publications.

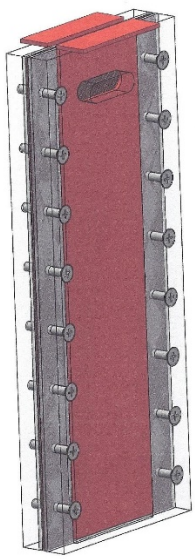

Fig. 4. Model of the Electrode Cell in the Electrochemical Reactor

The simplicity of the electrode cell design has determined the overall simplicity of the water treatment system.

Fig. 5. Photograph of the System for Real-Time Adjustment of Acidity and Alkalinity in Deionized Water

Photographs of the real-world prototype system demonstrate its designed simplicity, resulting in low costs and convenient operation. Such a system can be installed and operated with minimal expenses in virtually any retail outlet selling optical instruments and glasses, including both current and future models of augmented reality glasses.

Advantages of the System Design

A deeper structural analysis of the system's capabilities reveals its potential to significantly enhance the performance and quality of innovative products under modern conditions. The system offers flexibility for modification and optimization, paving the way for new technological advancements.

For example, the three-dimensional electrode model introduces new possibilities. Electrodes made from **carbon-carbon composite materials** are particularly noteworthy. In one potential design, an electrode consists of a titanium strip coated with a conductive polymer, with the water-facing side covered by carbon-carbon fabric. This fabric, created through pyrolysis and saturation with carbon, has excellent conductivity and permeability, enabling high performance even at extreme temperatures.

Applications Beyond Optical Cleaning

Experiments suggest that carbon-carbon fabric treated electrochemically can also be used to produce medical-grade wipes, demonstrating promising results in burn treatment and prevention. When paired with the system's dual-output water (acidic and alkaline), these wipes could serve as an additional tool for cleaning optical lenses with enhanced precision and safety.

The fabric could also be used in advanced modules for water purification and regeneration, including ion-exchange processes. For instance, carbon-carbon capsules filled with zeolite granules could be connected to a power source, allowing for ion-exchange purification combined with electromagnetic activation or heating.

Challenges in Patent Protection

Despite the innovative potential of such systems, patent protection activity remains low. A detailed analysis of the patent landscape highlights overlapping technical solutions, making it difficult to establish a clear foundational design. This ambiguity is compounded by the lack of consumer-oriented standards and guidelines for the operation and safety of such products.

Health and Safety Concerns

The long-term health effects of augmented reality glasses remain unstudied, raising concerns about their psychological and mental impacts on users. The novel

capabilities of these glasses may conflict with established consumer habits, potentially causing cognitive dissonance.

Recommendations for Market Introduction

To address these challenges, developers should focus on preparing consumers for the proper use and maintenance of these innovative products. Collaboration with insurance companies is essential to assess potential health risks. Additionally, the process of standardization and certification should be initiated early, aligning the product's specifications with existing industry standards.

Conclusion

The concept of augmented reality glasses holds significant potential but will be far more successful with the parallel development of service technologies and supporting equipment. Proper market preparation, including consumer education and technical standardization, will be critical to realizing the full potential of this innovative product class.

Results:

1. **Development of Deionized Water Cleaning Systems:**
   - Prototype systems were created to adjust the pH levels of deionized water for cleaning AR lenses.
   - These systems demonstrated the effective removal of organic and inorganic contaminants without damaging sensitive optical materials.
2. **Integration of Service Technologies:**
   - Proposals for scalable cleaning stations that can be installed in retail outlets and service centers.
   - Potential for using carbon-based composite materials in cleaning pads for enhanced performance.
3. **Patent Analysis:**

- Only 133 patent applications related to AR glasses and 20 concerning visualization technologies were found, indicating a need for more robust intellectual property development.

Conclusion. The future success of AR glasses depends not only on technological advancements but also on the development of comprehensive service technologies. Cleaning systems based on deionized water and robust maintenance frameworks will enhance consumer acceptance and long-term sustainability. Developers must prioritize these aspects to ensure the seamless integration of AR glasses into daily life.

List of References, Patent, and Licensing Information

Appendix 1

United States Patent Application	**20180031836**
Kind Code	**A1**
Johnson; Lonny Eric ; et al.	**February 1, 2018**

SMART GLASSES HAVING INTERFERING LIGHT FILTERING

Abstract

A pair of smart ***glasses*** having interfering light filtering includes a ***glasses*** frame defining a horizontal view path and a semi-transparent display supported on the ***glasses*** frame and positioned in the horizontal view path. A projection mechanism is supported on the ***glasses*** frame and has a projection lens positioned above the horizontal view path. The projection mechanism is configured for projecting virtual content on the semi-transparent display, with an outer surface of the projection lens facing a rear facing surface of the semi-transparent display. A semi-transparent polarized shield is supported on the ***glasses*** frame and is positioned below the horizontal view path, with an inner surface of the semi-transparent polarized shield facing the outer surface of the projection lens. The

semi-transparent polarized shield positioned to filter interfering light passing through the semi-transparent polarized shield and toward the projection lens.

Appendix 2

United States Patent Application	**20170307787**
Kind Code	**A1**
Kawamura; Takumi	**October 26, 2017**

HEAD MOUNTED APPARATUS AND GRIPPING APPARATUS

Abstract

A head mounted apparatus that prevents the influence of external light and is easy to use even for a user wearing ***glasses***. The head mounted apparatus includes a display unit that displays an image to the user, and a light shielding member that shields a periphery of the user's eyes from external light when the head mounted apparatus is mounted on the user's head, wherein an opening is formed on the light shielding member at the user's orbital regions.

Appendix 3

United States Patent Application	**20150378155**
Kind Code	**A1**
KUEHNE; Marcus ; et al.	**December 31, 2015**

METHOD FOR OPERATING VIRTUAL ***REALITY*** GLASSES AND SYSTEM WITH VIRTUAL ***REALITY*** GLASSES

Abstract

A method for operating virtual ***reality glasses*** involves displaying at least one virtual object by the virtual ***reality glasses*** from a virtual viewing position and continuously detecting a position of the virtual ***reality glasses*** and adjusting a virtual spacing between the virtual viewing position and the virtual object. Once the virtual viewing position passes through a surface bounding an element of the object from the outside, the representation of the element is altered. Furthermore, a system with virtual ***reality glasses*** may be used.

Appendix 4

United States Patent Application	**20160034042**
Kind Code	**A1**
JOO; Ga-hyun	**February 4, 2016**

WEARABLE GLASSES AND METHOD OF PROVIDING CONTENT USING THE SAME

Abstract

A wearable ***glasses*** is provided. The wearable ***glasses*** includes a sensing circuit, a communication interface, a display, and a controller. The sensing circuit senses movement information of a user wearing the wearable ***glasses***. The communication interface receives notification message information. The display displays the notification message information within an angle of view of the user wearing the wearable ***glasses***. The controller determines a movement state of the user based on the sensed movement information of the user and controls the display to display the received notification message information according to the movement state of the user.

Appendix 5

United States Patent Application	**20180005421**
Kind Code	**A1**
PARK; Jisoo ; et al.	**January 4, 2018**

GLASSES-TYPE MOBILE TERMINAL AND METHOD OF OPERATING THE SAME

Abstract

A ***glasses***-type mobile terminal includes a display configured to display a virtual ***reality*** image and a controller configured to acquire ***reality*** information from a mobile terminal connected to the ***glasses***-type mobile terminal and controlling the virtual ***reality*** image if a ***reality*** returning time indicating that viewing of the virtual ***reality*** image should be finished is reached based on the acquired ***reality*** information.

Appendix 6

United States Patent Application	**20170366805**
Kind Code	**A1**
SEVOSTIANOV; PETR VYACHESLAVOVICH	**December 21, 2017**

METHOD AND SYSTEM FOR DISPLAYING THREE-DIMENSIONAL OBJECTS

Abstract

A system for displaying three-dimensional objects using two-dimensional ***visualization*** means simultaneously providing at least effects of binocular parallax and motion parallax, the system comprising: a display configured to display a sequence of images; a pair of ***glasses*** configured to provide stereoscopic separation of images, the ***glasses*** comprising at least two optical shutters and at least two markers; two optical sensor arrays; two reading and processing devices configured to read data from an area of the optical sensor array and to determine 2D coordinates of the markers; a marker coordinates prediction device configured to extrapolate coordinates of the markers so as effective overall delay does not exceed 5 ms; a marker 3D coordinates calculation device; a 3D scene formation device; and at least one image output device. The invention also includes a corresponding method of displaying three-dimensional objects and provides realistic representation of three-dimensional objects for one or more viewers.

Appendix 7

United States Patent Application	**20170371164**
Kind Code	**A1**
Liao; Chunyuan	**December 28, 2017**

WEARABLE SMART GLASSES

Abstract

Smart ***glasses*** comprise a ***glasses*** frame. The smart ***glasses*** further comprise a pair of ***glasses*** legs connected to two lateral portions of the ***glasses*** frame respectively, each of the ***glasses*** legs having a first end and a second end, wherein the second end of each of the ***glasses*** legs bends inwardly to form a first arc portion. In addition, the smart ***glasses*** further comprise a pair of clamping members each disposed at one of the ***glasses*** legs, wherein each of the clamping members comprises an elastic clamping element, said elastic clamping element being disposed at the inner side of said second end, wherein said elastic clamping element having a free end that bends inwardly to form a second arc portion.

United States Patent Application **20160173865**
Kind Code **A1**
PARK; Sung Woo **June 16, 2016**

WEARABLE GLASSES, CONTROL METHOD THEREOF, AND VEHICLE CONTROL SYSTEM

Abstract

Wearable ***glasses*** include a first capturer for photographing a front part, a second capturer for tracking a gaze direction of a user, and a controller for matching a target image captured by the first capturer with a three-dimensional (3D) interior map of a vehicle, corresponding to the target image, and determining a head direction of the user. The controller specifies an object corresponding to user gaze in the target image based on the determined head direction and the tracked gaze direction of the user. Accordingly, user convenience is enhanced.