Journal of Electrotechnology, Electrical Engineering and Management (2023)
Clausius Scientific Press, Canada
DOI: 10.23977/jeeem.2023.060209
ISSN 2560-6697 Vol. 6 Num. 2

Designing Smart Navigation Eyewear with Augmented Reality Projection Technology: Development and Impact of Smart Wearables in the 5G Era

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Keywords: Communication Engineering, Wearable Devices, Smart Design, Smart Wearables, Fifth-Generation Communication Network (5G)

Abstract: The general term for wearable devices and smart designs in development is called "smart wearables". With the gradual improvement of the fifth-generation communication network (5G), fully functional smart glasses are becoming more and more integrated into our lives. Therefore, the purpose of this article is to design a smart navigation eyewear that provides navigation to users through augmented reality (AR) projection technology. This article also outlines the development of smart wearables at home and abroad in recent years, the impact of 5G on smart wearables, and different types of smart wearables.

1. Introduction

In the last century, smart wearable devices have started to enter people's mind. For example, watches, bracelets, glasses and clothing have been developed with smart features [1]. These wearable smart devices took shape and ideas in the 1960s and were continuously developed and improved in the following decades. Smart wearable devices were rapidly introduced during the 70s~80s [2], which marked the further enhancement of wearable technology and provided new possibilities for the extension of human intelligence. With the aid of artificial intelligence and wearable devices [3], people will be able to better perceive the outside world and their own information in the future [4]. In the field of computers and the Internet, we can even process data and information more efficiently by collaborating with others, thus achieving seamless communication [5]. In this paper, we will focus on the design of smart glasses and explore the value of their application in the field of communication engineering [6].

2. Related Work

2.1. Brief Description of Foreign Studies

In recent years, Google's Google Glass, released in 2012, may be the driving force behind the popularity of wearable smart devices. Many of the world's tech giants have turned their attention to the wearable smart device space. Surprisingly, traditional companies such as Internet companies

and electronics companies have also started to follow this trend and developed their own wearable smart devices, including well-known tech giants in the business sector such as Microsoft, Google, Samsung, Apple and Sony. In addition to these giants, many small and medium-sized companies have also launched their own competitive products, such as Pebble's smartwatch and the Oculus River virtual reality headpiece, both of which have entered the market with very good sales results [7].

Compared to traditional PCs and smartphones, smart wearables are attracting attention as they allow users to escape the limitations of these devices to a certain extent, creating a new type of mobile web portal with personalized data features [8-10]. In the operational experience and information interaction mode, wearable smart technology devices manage to be the input and output data terminals of mobile communication networks in the true sense of the word, freeing human hands and truly transforming people's experience in life, work and entertainment. The international wearable technology company market is entering an unprecedented period of explosion, a market costing $10 billion. Market research firm Bi Intelligence predicted that the number of tradable smart wearables worldwide in 2014 was around 100 million units. Just a few years later, in 2018 that number increased to 300 million units and will arrive at $120 in sales at an average cost of $42 per piece. Research firm ABI Research predicts that over the next five years, from 2018 to 2022, the wearable technology governance industry will enter a period of explosive growth and popularity. According to data estimates, the number of wearable technology devices that can be delivered for global wearable technology governance will reach 485 million units in 2018, with corresponding RMB sales of approximately $19 billion [11].

Wearable devices are closely related to public life and can be divided into four categories: infotainment, physical health, security and medical management [12]. Infotainment products mainly meet the needs of information dissemination and leisure life, such as smart watches and smart glasses, for example, Google Glass, Sony Smart Watch and Apple Watch. Physical health products are mainly used to monitor and alert people's data in fitness, such as Nike China's second-generation FuelBand sports wristband and Fitbit's third-generation smart treadmill system product Flex bracelet. Safety and protection products are mainly used to prevent the elderly from getting lost, such as the positioning shoes jointly developed by GTX and Aetrex USA with built-in GPS chip, which can help people suffering from Alzheimer's disease [13]. Healthcare products include blood pressure, heart rate, body temperature, blood oxygen level, respiration rate and blood glucose monitoring, with a focus on monitoring movement status and geographic location [14]. Bone conduction technology can be used for patients with tympanic membrane injuries. Examples include the Jawbone Health bracelet UP24 and the iHealth AM3 Nine Safety medical smartwatch.

2.2. Brief Description of Domestic Research

In recent years, with the rapid development of mobile Internet and Internet of Things technology, wearable smart devices are getting more and more attention. In this field, the international market has developed very mature, and many well-known technology companies such as Apple, Samsung and Google have launched their own wearable devices and achieved notable sales results. Meanwhile, traditional companies have also started to enter the field, such as Cartier's smart watch and Swarovski's smart necklace.

However, compared to the international market, the domestic wearable smart device market is still in its infancy. Although some Internet fintech companies have started to plan the development of the wearable device industry, there is still no mature market system. Domestic manufacturers are also facing many challenges, such as technical bottlenecks and low brand recognition.

Despite the current state of the market, the potential of the wearable smart device market is still huge. Currently, many startup teams have emerged in the domestic market, such as Shanda Fruit Shell Electronic Smartwatch, Baidu and TCL Smart Bracelet, Baidu Eye's internal measurement, 360 Children's Defender, ZTE Big Watch, Huawei's Talk Band Bracelet, New Soft Haikang Watch, Xiaomi Bracelet, Inci Technology, Han Wang, etc.

These companies continue to innovate in the field of wearable smart devices, developing more diversified products with more comprehensive functions. For example, in addition to products for infotainment and physical health, there are also products for safety and protection and healthcare. These products can play an important role in lost elderly people, sports monitoring and medical management.

Therefore, it is foreseeable that the wearable smart device market will grow further in the coming years. Although it will take time to develop, the domestic wearable smart device market will also become more vibrant as the technology continues to innovate and the market gradually matures. The aspects to be considered in the design of smart navigation glasses are shown in Table 1.

Table 1: Aspects to consider in the design of smart navigation glasses

Design Requirement	Description
Size and Weight	The smart glasses should be designed to be as small and lightweight as possible to ensure wearer comfort.
Interface Design	The interface should be designed with a transparent display, typically using a flat graphical user interface.
Lens Selection	Provide multiple lens options, such as clear and tinted lenses, to adapt to different environments and use cases.
Sensors	Incorporate multiple sensors, such as GPS and gyroscopes, to ensure accurate navigation and positioning.
Wireless Connectivity	Given the need to connect with smartphones and other devices, the smart glasses should possess wireless connectivity capabilities for interacting and transmitting data.
Interaction Methods	User-friendly interaction methods should be designed, such as gesture recognition and voice interaction, through wearable device software development kits (SDKs) and other means.

2.3. The Contribution of 5G to Smart Wear

Smart wearable devices, such as smart watches, smart glasses, and smart clothing, are an important component of future intelligent living. These devices can collect data on users' physical and environmental conditions through sensors, and transmit this data to the cloud for processing, enabling various intelligent functions and services such as health monitoring, sports activities, remote communication, and virtual reality.

However, the application and development of smart wearable devices face many limitations and challenges, especially in terms of network issues. In traditional 4G networks, the application of smart wearable devices is greatly restricted due to limitations in network speed and stability, such as sensor data collection, remote control, and real-time communication.

The emergence of 5G technology has solved these problems, improving not only network speed and stability, but also energy efficiency and capacity, promoting the popularization and development of smart wearable devices. With the support of 5G technology, we can achieve faster, more reliable and lower latency data transmission, while also greatly improving network capacity

and utilization, providing a broader space for the application and development of smart wearable devices.

Firstly, 5G technology has faster network speeds, which enables richer application scenarios such as more intuitive operation experience using voice and images. In addition, in terms of low latency, 5G technology can control the delay at millisecond level, achieving faster response times.

Secondly, 5G technology is more energy-efficient, reducing the transmission power consumption of smart wearable devices and prolonging device life. In addition, due to the higher network capacity of 5G technology, it can support more devices and user access, enhancing the scalability and communication quality of smart wearable devices.

Finally, 5G technology also provides more rich and stable network services, which will help develop richer and more stable applications, improve user experience, and provide better protection for the commercialization of smart wearable devices.

In conclusion, 5G technology has a significant promoting effect on the development and application of smart wearable devices, leading to a new round of market explosion. The emergence of 5G technology will greatly promote the development and application of smart wearable devices, promote the shift to high-end, specialized, and differentiated smart wearable products, and potentially lead the new technological upgrades and market explosion of smart wearable devices.

3. Existing Smart Wearable Devices

3.1. Smart Watch and Smart Bracelet

Smart watches are an upgraded version of smart wristbands. They look like regular watches but have powerful computing and data processing capabilities similar to smartphones. Smart watches can run on existing operating systems like Android or iOS (iPhone OS) and can connect to smartphones via an integrated Bluetooth communication module, allowing synchronization of features like calls, messages, and music. Smart watches have gained significant popularity in the consumer market and come in two main types: those that can only connect via Bluetooth and do not support calling, and those that can connect to a user's mobile network through a Subscriber Identity Module (SIM) card for calling. Regardless of the type, smart watches offer people convenient and practical functions to help manage their daily lives and health.

Let SW denote the set of all possible smart watches. A smart watch $w \in SW$ can be represented as:

$$w = (OS, BT, SIM, Sensing) \quad (1)$$

where OS refers to the operating system running on the smart watch, BT is the Bluetooth communication module, SIM indicates whether the smart watch supports calling via a SIM card, and Sensing represents the various sensors on the watch that allow it to track metrics such as steps, heart rate, and sleep quality.

With the ability to track these metrics, smart watches can remind users to exercise regularly and maintain a healthy diet. Additionally, smart watches can act as remote controllers for home appliances or music playback, making them extremely useful portable devices that allow us to conveniently handle various tasks, ultimately enhancing our quality of life. The Rokit smart glasses product diagram is shown in Figure 1.

Figure 1: Rokit smart glasses product diagram.

The following is an introduction to smart wristbands. The heart rate detection function in smart wristbands mainly uses photoplethysmography and transmittance measurement methods. The working principle is that the sensor built into the smart wristband emits a beam of red or green light onto the user's wrist and the wristband has a receiver that receives reflected or transmitted light. When the heart pumps blood, some special wavelengths of light are absorbed in large quantities, and the heart rate can be indirectly reflected by calculating the number of heartbeats per minute.

Smart wristbands are portable electronic devices that are usually worn on the wrist and have multiple functions. Heart rate monitoring is an important function of smart wristbands that can help people better understand their physical condition, remind users to rest and exercise, and provide health advice. In addition, smart wristbands can also monitor sleep and provide suggestions for improving sleep quality. Due to its small size, light weight, and ease of wear, smart wristbands have become an essential tool for many people's daily health management. The current famous smart bracelets are shown in Table 2.

Table 2: Introduction of some famous smart bracelets at present

Smart Bracelet Brand	Compatible Mobile Brands	Main Functions
Fitbit Inspire 2	Apple, Samsung, Android, and Windows devices	Heart rate monitoring, sleep tracking, activity tracking, calorie tracking, message notifications, GPS tracking
Xiaomi Mi Band 6	Apple, Samsung, and Android devices	Heart rate monitoring, sleep tracking, activity tracking, calorie tracking, message notifications, music control
Garmin Vívofit 4	iPhone, Samsung, and Android devices	Step counting, distance tracking, calorie tracking, sleep monitoring, weather updates, timer and stopwatch
Huawei Band 6	Huawei and Android devices	Heart rate monitoring, sleep tracking, activity tracking, calorie tracking, message notifications, music control
Samsung Galaxy Fit2	Samsung and Android devices	Heart rate monitoring, sleep tracking, activity tracking, calorie tracking, message notifications, music control

3.2. Smart Glasses

The product includes a hanging ear glasses, charging compartment, charging cable, manual, professional care solution. The use of the product also needs to be combined with the company's APP; the download method is attached to the first page of the manual. The frame can choose its own color, the color classification includes sunset brown, red birch brown, smoky black, brown

gray gold, caramel crystal calm, cherry soft pink, glacier lake blue, morning fog gray, turquoise Mori green, etc.

3.3. Development of Technologies Related to Smart Navigation Glasses

3.3.1. The use of Mobile Augmented Reality (AR) Technology

Augmented reality technology has a wide range of applications and has great potential for mobile applications in particular. With the increasing performance of mobile devices and sensor integration, as well as the development of computer vision technology and network technology, mobile augmented reality technology has been widely used in areas such as tourism and guided tours, entertainment and business, training and education, assembly and repair. Among them, environment perception technology is one of the keys to build a successful mobile augmented reality application. Environment-aware technology can identify the objects and events near the user that need to be augmented, which leads to a better information interaction experience.

Target detection technology is one of the important methods to achieve environment perception. In recent years, great progress has been made in deep learning-based target detection algorithms, which can steadily and accurately identify objects in the environment in complex scenes. Combining target detection with mobile augmented reality technology can bring a more convenient and efficient interaction experience for users, as well as a bailiwick and innovation for technology integration.

However, there are still some difficulties and challenges due to the limited computing power of mobile augmented reality devices, high energy consumption, large model size, and network latency that requires connection to a remote cloud. In the future, with the further improvement of mobile devices and sensor integration performance, as well as the continuous development of computer vision technology and network technology, augmented reality technology and mobile augmented reality technology will be more widely used and promoted.

Smart navigation glasses are a series of features added to smart glasses, the most prominent of which is AR projection to enable navigation. This technology can project navigation instructions and maps and other information directly into the user's environment, allowing the user to access navigation information more easily and quickly. At the same time, the smart navigation glasses can also achieve the recognition of objects and events in the surrounding environment through environmental awareness technology, so as to provide users with more intelligent navigation services.

In addition to smart navigation glasses, mobile augmented reality technology is also widely used in the entertainment and business sectors. For example, in games, players can achieve a more immersive gaming experience by integrating the performance of mobile devices and sensors to blend the virtual and real worlds. In the business field, mobile augmented reality technology can help companies improve product display and marketing, for example, displaying products through augmented reality technology to bring customers a more vivid and intuitive shopping experience.

3.3.2. Target Detection Problem

Objects are detected by finding the objects of interest in the corresponding images. This effectively involves providing their categories and detailed positions (in the form of bounding boxes). Object detection is a core problem in computer vision technology. The number, appearance, shape, posture, as well as the lighting conditions, occlusion, and differences in viewpoint during target imaging, can all bring challenges to object detection. Traditional object detection algorithms are based on manually designed feature construction. Due to the lack of effective methods for image

representation, various complex feature representations have been proposed. Differential acceleration methods have been used to apply limited computing resources. Traditional object detection algorithms mainly consist of four stages for detecting objects in input images:

$$\text{Detection} = \{(x, y) \mid x \in D, g(x) > t\} \quad (2)$$

Where Detection is the set of detected objects, D is the set of all possible object locations in the image, g(x) is the objectness score at location x, and t is a predefined threshold value. The various stages of target detection are shown in Table 3.

Table 3: Stages of target detection

Stage	Description	Techniques
Preprocessing	Preparing input data for analysis by removing noise, enhancing contrast, and improving image quality	Cropping, resizing, normalization, color correction
Feature extraction	Identifying and extracting relevant features from the preprocessed image to differentiate the target object from the background	Shape analysis, texture analysis, color analysis, orientation analysis
Classification	Applying a classification algorithm to determine whether the target object is present in the image	Decision trees, neural networks, support vector machines (SVMs)
Postprocessing	Refining the output of the classification algorithm to improve its accuracy and reliability	Filtering false positives, adjusting detection threshold, smoothing output over time

4. Summary and Outlook

Now the 5G era is coming, which will bring faster data transmission speed and lower communication latency. 5G technology is one of the key technologies of edge computing, where gateways, servers and other devices are deployed in the edge space near the incoming side to increase the computing technology capability to process and transmit data such as low latency services and local data at the edge, which can be returned to the core without passing through the transmission information network, which is the network. This way we can get improved user experience by reducing latency also can effectively reduce the backhaul pressure. In the past, when 5G was not yet available, smart wearable devices were still more of a concept, even if there was still only initial development. But with the popularization of 5G, research related to technology, usage, data security and privacy protection of smart wearable devices has been gradually improved and matured. Now many companies in the world with a good technology base are gradually paying attention to the development and feasibility of wearable devices, and smart navigation glasses will play an important role and occupy an important position in the future.

References

[1] Rejeb A, Keogh J G, Leong G K, et al. Potentials and challenges of augmented reality smart glasses in logistics and supply chain management: A systematic literature review. International Journal of Production Research, 2021, 59(12): 3747-3776.

[2] Zhang Z, Wen F, Sun Z, et al. Artificial intelligence-enabled sensing technologies in the 5G/internet of things era: from virtual reality/augmented reality to the digital twin. Advanced Intelligent Systems, 2022, 4(7): 2100228.

[3] Gupta R, Tanwar S, Tyagi S, et al. Tactile internet and its applications in 5G era: A comprehensive review. International Journal of Communication Systems, 2019, 32(14): e3981.

[4] Morimoto T, Kobayashi T, Hirata H, et al. XR (extended reality: virtual reality, augmented reality, mixed reality) technology in spine medicine: status quo and quo vadis. Journal of Clinical Medicine, 2022, 11(2): 470.
[5] Cao J, Lam K Y, Lee L H, et al. Mobile augmented reality: User interfaces, frameworks, and intelligence. ACM Computing Surveys, 2023, 55(9): 1-36.
[6] Syed T A, Siddiqui M S, Abdullah H B, et al. In-Depth Review of Augmented Reality: Tracking Technologies, Development Tools, AR Displays, Collaborative AR, and Security Concerns. Sensors, 2022, 23(1): 146.
[7] Baroroh D K, Chu C H, Wang L. Systematic literature review on augmented reality in smart manufacturing: Collaboration between human and computational intelligence. Journal of Manufacturing Systems, 2021, 61: 696-711.
[8] Lee L H, Braud T, Hosio S, et al. Towards augmented reality driven human-city interaction: Current research on mobile headsets and future challenges. ACM Computing Surveys (CSUR), 2021, 54(8): 1-38.
[9] Apostolakis K C, Dimitriou N, Margetis G, et al. DARLENE–Improving situational awareness of European law enforcement agents through a combination of augmented reality and artificial intelligence solutions. Open Research Europe, 2022, 1: 87.
[10] Lavingia K, Tanwar S. Augmented reality and industry 4.0. A Roadmap to Industry 4.0: Smart Production, Sharp Business and Sustainable Development, 2020: 143-155.
[11] Noh Y, Shin Y. A Study on the Plan of Activation of Library by Utilizing the Virtual Reality and Augmented Reality. International Journal of Knowledge Content Development & Technology, 2022, 12(1): 85-104.
[12] Voinea G D, Gîrbacia F, Duguleană M, et al. Mapping the Emergent Trends in Industrial Augmented Reality. Electronics, 2023, 12(7): 1719.
[13] Hasan R, Hasan R. Pedestrian safety using the Internet of Things and sensors: Issues, challenges, and open problems. Future Generation Computer Systems, 2022.
[14] Masood T, Egger J. Augmented reality: focusing on photonics in industry 4.0. IEEE Journal of Selected Topics in Quantum Electronics, 2021, 27(6): 1-11.