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### ARTICLE

# DESIGN RESEARCH BASED ON WEARABLE DEVICE AND AR TECHNOLOGY — A CASE STUDY OF TREATMENT FOR PATIENTS WITH DENTAL ANXIETY

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### ARTICLE DETAILS

### ABSTRACT

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This paper focuses on exploring the possibility of alleviating the common “dental anxiety” in dental treatment through wearable devices and AR technology and improving the user experience in the treatment process of patients with dental phobia in order to facilitate dentists to provide treatment and improve the efficiency of dental treatment. Through literature review, the direct and indirect causes of dental anxiety were sorted out, and the existing solutions to dental anxiety were summarized. According to the five aspects of user experience, the user experience factor model for dental anxiety patients was constructed. The results of the analysis showed that the use of wearable devices with AR had good compatibility with easing anxiety of user due to “the drill voice”, “scary scenes” and “unknown factors of dental treatment”. It proved that wearable and AR technology of equipment has application feasibility on easing dental anxiety. By analyzing the possibility of using wearable devices and AR technology to improve the user experience of dental anxiety patients, wearable devices and AR technology can meet the needs of relieving dental anxiety, and provide ideas and innovations for the design and development of relieving dental anxiety.

#### KEY WORDS

Dental anxiety, User experience, Wearable devices, AR

## 1. INTRODUCTION

Dental Fear/Dental Anxiety (DF/DA), also known as Dental phobia, is a common phenomenon in patients with Dental diseases. It is one of the main reasons for patients in stomatology department to avoid oral treatment. Some patients avoid or delay treatment due to DA and miss the best treatment opportunity, leading to the in-depth development of oral diseases, which not only prolongs the treatment process and increases the treatment cost, but also seriously affects physical and mental health [1]. In 2012, Google released the first commercial AR glasses — Google Glass, and AR glasses entered the view of consumers as a new intelligent wearable device. AR technology is characterized by “the combination of virtual and real-world information”, “real-time interaction” and “positioning virtual objects in three-dimensional space”, which can bring new changes to dental treatment methods [2]. Starting from the user experience of patients with dental anxiety, this paper will study the possibility of combining AR technology with dental treatment, and provide ideas for the design and development of AR smart glasses for dental treatment.

## 2. WEARABLE DEVICES AND AR TECHNOLOGY

Head-mounted smart glasses are wearable devices with glasses as the carrier. Head-mounted smart glasses perfectly combine real information and virtual information, and carry out data collection, recording, storage, display, transmission and analysis through glasses [3]. Wearable devices

are intelligent portable devices that wear sensing devices on the body. Currently, common wearable devices include contact, implant and external devices. Wearable devices not only contain hardware devices, but their powerful functions are more reflected in the application of information technologies such as software support, data interaction and cloud interaction [4]. Augmented Reality (AR) technology, which performed as a new interactive technology, has gradually appeared in the vision of consumers and aroused attention. AR technology generates virtual objects through software and superimposes them on the real world, so as to enrich users' perception of the real world and effectively enhance user experience. The current mainstream REALITY devices of AR include computer screen display device, handheld mobile display device and head-mounted display device [5]. This paper mainly discussed and studied head-mounted AR smart glasses.

At present, smart phones can basically meet demands of users in daily life, but in some industries, smart wearable devices are still in great demand.

1. Remote collaborative office: AR technology has the characteristics of integrating virtual information and real information, so that office workers in different locations can share the same working space. Meanwhile, the real-time feedback greatly improves the efficiency of remote collaborative office.

2. Security guarantee: AR technology can facilitate the office work of

law enforcement officers. Law enforcement officers can use AR glasses to quickly carry out identity identification, vehicle inspection and other security work.

3. Medical training: Medical staff can use AR equipment to watch real-time broadcast of surgery through 5G technology, and observe and learn new medical technology. Also targeted medical equipment simulation training can be carried out, so that operation is not affected by the site and time.

4. Mobile health: AR remote guidance system was applied to the front line of fighting against COVID-19 during the COVID-19 outbreak, which played an important role in alleviating the shortage of medical resources and avoiding overlapping [6].

5. Emergency rescue: The Israeli military has set up AR laboratory, using "Hololens", an AR head-mounted display developed by Microsoft, for rescue teaching and remote assistance in field operations. Augmented reality technology has achieved a high degree of information sharing on the rescue site, which is conducive to timely decision-making by rescuers [2].

AR has advanced technology because of three significant characteristics: the integration of real space and virtual space information, real-time interaction, and positioning virtual objects in three-dimensional scale space. It has achieved good results in many fields, but also has some limitations. At present, the production cost of AR equipment is too high. The production cost of Microsoft Hololens is estimated to be 1500 DOLLARS, so it is not realistic to use AR intelligent equipment in a wide range. The current AR technology does not have enough computing power, and the technology is still not enough to allow users to have a low-latency experience in use. The problem of ARTIFICIAL intelligence recognition is still not solved. Accuracy is critical in the medical field, and the recognition ability of current AR technology has not reached enough accuracy. Experts believe that in the future, when the hardware configuration of handheld terminal is strong enough, AR technology can be used in more important diagnosis and treatment of medical institutions [7].

**3. DENTAL ANXIETY FROM DIFFERENT PERSPECTIVES**

Foreign studies on DF were carried out earlier, mainly on the quantification, consequences, influencing factors and intervention of dental anxiety. DF studies in China gradually began in recent years. In recent five years, studies on positive aspects of dental anxiety showed an upward trend. Studies are mainly conducted on the causes, related factors, treatment methods and treatment object of DF [1].

From the point of view of patients, traumatic dental treatment, pain during dental treatment, bad attitude of dentists or other unpleasant experience: The sound of dental drill or ultrasonic cleaning machine;

Anesthetics, hammer when tooth extraction, long opening time, tired, saliva, nausea; Whether the disinfection is safe, whether the medical skill is exquisite and whether the diagnosis and treatment process is controllable are all factors that affect DF generation.

From the perspective of health care professionals, women have higher levels of dental anxiety than men. Studies show that dental anxiety is negatively correlated with age, and the anxiety level decreases with the increase of age, which may be related to the social experience and knowledge accumulation of patients, but it cannot be simply determined that the elderly are not nervous or afraid of dental treatment. Low-income people have higher anxiety scores, and the higher the income, the lower the anxiety level. Jiang yinyang found that 40 percent of patients felt anxious that the privacy was violated when they are watched. Dental traumatic treatment experience is generally believed to have an obvious relationship with anxiety [8].

**4. RESEARCH HYPOTHESIS**

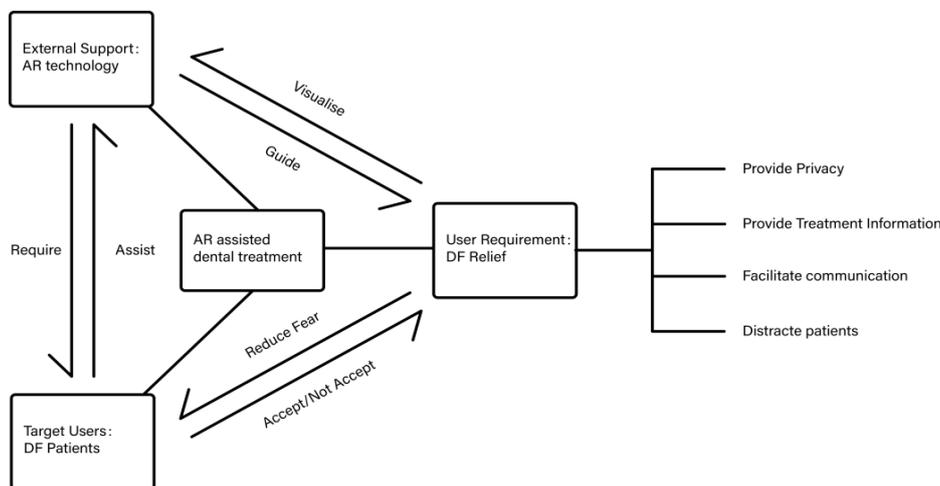
The current treatment methods for DF mainly include behavioral therapy, pharmacological therapy and organic relaxation therapy. Behavioral therapy includes "speaking-playing-doing" method, relaxation method, cognitive method, systematic desensitization method, exposure therapy and psychological environment method. Pharmacological therapy mainly uses sedatives or anesthetics to relax the patient. Organic relaxation means the use of massage, aromatherapy or SPA to relax the patient. Existing treatment methods mainly focus on patients' four senses of sight, hearing, smell and touch to alleviate DF symptoms. AR technology, as a tool to enhance realistic feelings of users, has a good match with the current treatment methods, which is of great help to improve DF symptoms of patients [1].

**4.1 Constructing Psychological Environment with AR Technology**

Some of the physical environment factors, such as the dentist group wearing non-clinical clothes and playing background music in order to address the feelings and smells on the dentist, can be used to help patients reduce the stimuli and sensations triggered by fear. Therefore, AR technology can intervene in the treatment process, distract attention of patients through images, videos and even movies on smart glasses, and separate patients from the fearful dental clinic space and medical instruments. In that private space for patients is provided, and a friendly psychological environment is built.

**4.2 Facilitating Communication with AR Technology**

Experts say high levels of fear should not be seen as a problem solely with the patient, but rather the relationship between the patient and the dentist. The real-time interaction of AR technology can be applied to the communication between patients and doctors. Patients feedback their current feelings through gestures, and doctors make corresponding



**Figure 1:** Removing doubts with AR technology

treatment adjustments based on the feedback information of patients. Thus, the psychological burden and anxiety in the treatment process could be reduced.

#### 4.3 Removing Doubts with AR Technology

The Treatment information, the duration of operation and the treatment process of controllability are what patients want to get. During the process of treatment by using AR technology virtual overlay the characteristics of information and the reality, which can make patients in the process of real-time access to treatment including duration, information such as the operation content, operation purpose, and greatly reduce unknown fear.

#### 5. CONCLUSION

The wide application of AR technology in different fields has changed the traditional way of product design and provided technical support and visual display of interface design for designers and product developers. In this paper, by analyzing the possibility of using wearable devices and AR technology to improve the user experience of dental anxiety patients, wearable devices and AR technology can meet the design needs of relieving dental anxiety, and provide ideas and innovations for the design and development of relieving dental anxiety. AR augmented reality technology, which can combine virtual and reality, has seen initial application in the medical field. The application of AR technology in the new medical field can greatly optimize the allocation of medical resources due to its unique technical attributes. Especially in the fields of telemedicine and live surgery, AR technology enables more patients to enjoy sophisticated medical equipment and improve their medical experience. However, existing AR glasses are rarely used in the medical field, and AR glasses are not professionally designed for the medical industry environment. In the future, with the progress and improvement of AR technology itself and the development of new medical industry,

the research on AR intelligent devices in specific medical environment will be more in-depth, and professional AR devices suitable for specific medical environment will appear.

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