Digital Life 2030+

vivo Communications Research Institute

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While 5G commercial networks are gradually deployed around the world, the industry starts focusing on research and exploration of 6G. The mainstream view is that 6G is expected to be commercialized around 2030[1,2,3,4]. The first step of 6G research is to reach an industry consensus on the goal of 6G, i.e., what are the services and applications in the era of 6G?

With the continuous development of ICT, what changes will be brought to people's lives after 2030? vivo Communications Research Institute (vCRI) launched a collection of 6G application scenarios and use cases with the theme of 'Imagine the Digital Life in 2030+' , and received more than 800 works from university graduates of different majors, as well as over 20 senior experts and media reporters majoring in digital technology. These works and creations reflect the customers' expectation on the future digital life. In order to make the scenario prediction more scientific and realizable, vCRI further studied the forecast reports towards 2030 of related industries, and the roadmap and planning of several government agencies for the next decade, and finally wrote this white paper.

In this white paper, vCRI analyzes 11 aspects that are closely related to people's lives in 2030 and beyond, and presents 29 use cases to provide an image of the digital life in 2030 for customers and industries. The 11 aspects include clothing, food, housing, transportation, learning, work, entertainment, medical treatment, healthcare, the environment and safety. It is expected that this white paper will be helpful to the research work on 6G vision and requirements.

Digital life in 2030
and beyond

01

Before looking ahead to the digital life in 2030 and beyond, let's take a look back at changes in the last decade. 4G has been commercially available since 2010 and 5G started gradual commercial deployment in 2019. With the popularity of smartphones and widespread deployment of broadband network, a huge Mobile Internet industry comes to people's lives. The Mobile Internet makes it easier to access and exchange information, and bridges the gap between demand and supply, enabling new industries to emerge. Mobile APPs have changed people's life styles in terms of socializing, consuming and mobile payments.

In the past decade, cloud computing and big data have evolved from initial concepts to large-scale commercial applications[5], and Artificial Intelligence (AI) has evolved from academia to the market and is widely distributed in 18 application fields[6]. These three important tools (cloud computing, big data and AI) are transforming the industrial society into an information society. Blockchain technology, emerging from the concept of Bitcoin, is rapidly expanding its application fields and scopes. In the area of hardware, Moore's law is still in effect, and we are pleased to see mainstream semiconductor processors evolving from 28nm to 5nm and towards more advanced 2nm techniques[7]. In addition, fundamental science continues to evolve with breakthroughs in technologies and new materials such as quantum computing[8], brain-computer interface[9], graphene[10], etc.

As we look beyond the next decade, ICT will continue to evolve at a rapid pace. ICT and related basic sciences such as life and brain cognition will reinforce each other to accelerate the introduction of revolutionary innovations into people's lives. It is expected that 6G will be commercially available after 2030. By that time, a complete digital twin world will be built, thanks to the high capabilities in connectivity, communication, computing, intelligence and the data-infrastructure of 6G. In the nearly freely connected physical and digital integrated world, a large number of innovative products and services will make the future digital life simpler, happier and more efficient. Taking the company vision of 'to be the bridge connecting humans and the digital world', vivo is committed to providing customers with the ultimate experience of intelligent terminal products and intelligent services.

What innovative products and services will emerge and how will people's lives change in the era of 6G? In Section 2 to Section 12 of this paper, predictions on future trends, use case descriptions and technical challenge analysis are provided focusing on 11 areas of people's life. They are clothing, food, housing, transportation, learning, work, entertainment, medical treatment, healthcare, the environment and safety. Now, please follow the main characters of this article, Ms. Gigi and Mr. Six, to experience the digital life in 2030+ together.

Clothing

02

Clothing, food, housing and transportation are the four basic needs of human beings. People's pursuit of clothing has evolved from the original goal of keeping warm and covering the body, being comfortable and decent, revealing status, and gradually to the goal of becoming beautiful, fashionable and personalized. In the future, technology will give more functions to clothing and continue to enhance people's pursuit of beauty and individuality.

In 2030+, ubiquitous IoT will enable very small and light wearable devices to be integrated into clothing, shoes, hats and accessories. Future clothing will be not only beautiful and fashionable, but also more functional and intelligent. In terms of individuality, thanks to the end-to-end connectivity of intelligent factories and agile manufacturing, the pursuit of 'made-to-measure' fashion and personalization will be available to the public, and give everyone the right to define their own fashion. In terms of functionality, by sensing, connection technologies, intelligence system and novel fabrics, manufacturers in the future will be able to produce high-tech and eco-friendly clothing, which is comforter and providing more functionality while keeping stylish. For example, clothing that can automatically adjust the thermal insulation coefficient can avoid looking fat in dress in winter while keeping warm. The clothing can be cleaned and maintained automatically to reduce the environmental pollution caused by chemical detergent. The clothing's color and pattern can be adjusted according to the emotion and events, to meet the individual fashion needs.

Extended reality (XR)[11], holographic image, AI and other technologies will bring about fundamental changes in clothes purchasing. Customers can experience realistic fit through holographic virtual fitting and feel the texture of clothes by using haptic scene communication. AI 'stylists' and AI 'makeup artists' can help you match the best clothes and makeup[12] based on your personal image and daily activity.

The Magic Swimsuit 2030

■ Scene description

After the graduation ceremony in the summer of 2030, I made an appointment with some friends to take a trip to the beach. Before going out, I found that there was no suitable swimming suit in my closet. Standing in front of the wardrobe mirror, I searched 'beach swimsuit' by voice. This smart wardrobe would analyze my shopping preferences and give recommendation. According to my body shape data, clothing in the wardrobe and current swimsuit fashion, it quickly recommended several suitable swimsuits. I chose one of the best-selling swimsuits named as ' The Magic Swimsuit 2030', and shook my phone to complete the payment, and selected the 'follow me' delivery mode before setting off for the beach.

When I arrived the beach, the delivery drone also arrived at the same place by precise positioning. It delivered me the swimsuit I ordered, including a smart swimsuit and a pair of AR swimming goggles. This swimsuit is fashionable in style, convenient and comfortable to wear because it adopts the latest professional swimsuit material. The swimsuit has the function of automatic temperature-regulating, which can automatically adjust to the most comfortable temperature by sensing the difference between the human body temperature and the external water temperature. Surprisingly, the suit is equipped with a flexible 6G communication module, which is invisible and cannot be felt when I wear the suit.

After touching the logo on the suit with my phone, the swimsuit system completed the pairing and became my dedicated swimming instructor. The smart suit can recognize the swimming posture and perceive swimming speed by multiple sensors, and then upload the data to a cloud coach system. After that, the smart suit can take an AI based analysis, to provide professional suggestions through the AR swim goggles. It can display my swimming posture and give the corresponding corrective suggestions in real time.

After 10 minutes of training, the AR swim googles showed I got a score of 90 in swimming. My swim was 30% faster than my historical best.

'Don't give up. Hold on for another 10 minutes and you still have 20% improvement.' Just when I wanted to stop for a rest, the goggles read my mind and gave me some voice encouragement. In 2030, a non-invasive brain-computer interface technology has made some progress. Although it cannot accurately read complex thinking activities and imaginary pictures of human beings, it can accurately capture strong emotional messages, such as tension, joy, sadness, frustration, as well as some simple control instructions such as 'up, down, left, right, on, off', etc. These functions can be used to a number of innovative applications.

I kept on training, and the AR goggles showed that I had swum for 30 minutes and 1,200 meters, and burned 1,400 calories. Just as I was slowing down to go ashore to enjoy the sunshine and sea breeze, my AR goggles suddenly alerted me that there was a child at 80 degrees in the left rear and 10 meters away that required emergency help. That child's swimsuit detected warning of drowning based on the pressure sensors on the swimsuit and other motion parameters, and it sent a rescue signal to safety inspectors and a few more skilled adult swimmers nearby. To avoid unnecessary sacrifice, the system is smart enough to filter out teenagers and the unskilled swimmers and does not send the rescue signal to them. Under the guidance of my goggles, I swam to the child as fast as I could and lifted the child up. At that moment, the rescue boat also got there and the child was rescued.

I took some relaxation in a beach chair. By sensing the UV index, the swimsuit read my body index in real time and give me a reminder: I need sunscreen in time to prevent the UV rays. While I was putting on the sunscreen, a young handsome man, the saved child's brother, Mr. Six, found me and gave me a drink for gratitude. During the conversation, my smartwatch alerted me that my 'heart rate index' was exceptional (above 120 in motionless state). It seemed Mr. Six's smartwatch also vibrated.

The Magic Swimsuit 2030 made my graduation beach trip full of surprises. The seeds of love were sprouting in the sea breeze.

A thin and light communication module is a prerequisite for the realization of the Magic Swimsuit 2030. In order to achieve light and soft, and support communication between AR goggles and the network, 6G terminals need to be continuously evolving in terms of size, cost and power consumption.

Miniaturized high-performance sensors, low latency data transmission capability, partial maturity of brain-computer interface technology, and powerful AI capabilities are the foundation of the dedicated swimming coach.

The collaborative use of the smart wardrobe, swimsuit, AR glasses, smart phone and other terminals requires the assistance of the network and the support of convenient short-distance communications, and more importantly, the interconnection and interworking of high-level interfaces. Emergency rescue functions require low-latency data transmission, precision positioning, and AI capabilities.

In addition, the security of personal information is particularly important. The reasonable utilization of personal data information is the foundation of intelligent and humanized intimate services such as smart shopping, 'following me' delivery, dedicated coaching and sun protection. How to achieve safe and standardized access to the personal data information is not only a technical issue, but also related to laws and regulations.

Private Customization

■ Scene description

Next week, I'm going to join vivo's Public Relationship (PR) department. A Human Resources (HR) assistant has informed me that there will be a welcome meeting for newcomers on that day. As a graduate, I did not know what clothes I should wear. I went to a shopping center and entered the store of my favorite brand. A pretty robot assistant approached me with a kind and warm voice, 'Good afternoon, Miss Gigi, welcome to Splend (a brand name) again. What can I do for you today?' By 2030, such intelligent service robots will be very popular. They can not only provide basic shopping guide services, but also automatically adjust their voice and selling style based on customer preferences. Besides, they are familiar with the spirit of clothing brands and can quickly identify customers, just as senior 'stylist'.

'I'll join vivo next week. Could you help me recommend an appropriate suit for the welcome party, please?' I replied.

'In order to better recommend clothes and save your time, would you please allow me to access your Type A personal data? Please don't worry because no personal data will be stored by the merchant. Of course, if you like to share your personal data without your sensitive information to assist our designers with continuous improvement and enhancement, we can give you a headpiece for free. If you allowed, look into my eyes and nod.' In 2030, the government will categorize personal data in different categories, and legislate the proper use of data. The non-trace access is the default data access mode. Type A data information includes basic personal information, basic physical appearance information, as well as personal portrait information such as occupation, dressing preferences and hobbies; Type B includes medical and health related parameters such as blood type and physical signs parameters. Type C includes more private information such as education, work

experience, family background, income, interests and personality, etc.

'Okay, I like the headpiece.' I looked at the robot and nodded, then I was led to the magic fitting mirror, where a fully three-dimensional (3D) digital duplication of me appeared in front of me. I just need to say 'next', then the 'me' in the mirror will change into different clothes recommended by the robot.

I moved my arms, jumped, bent over, and turned around to experience the effect of clothes without delay. I could also see the effect on the side and back of my clothes by gesture control. The robotic guide professionally explained to me the effect of clothes on the body, clothes designer, design concept, appropriate people and other information.

Finally, I chose a dress and the robot assistant took out a sample from the rotating smart wardrobe. I was very happy with the texture of the garment as I saw and felt it. 'This is just a sample of the basic model, it will be tailored to your body shape and appearance. You can also give other customization requirements,' said the robot assistant. To give a surprise to my colleagues, I chose to print the dark 'v' on the buttons and belts. I tried again in mirror mode and said, 'Excellent, I'll take it.'

I chose to deliver the clothes to my home by drone. The system showed that the clothes would be delivered within 24 hours. When I walked out of the store, the robot assistant waved me goodbye. It recognized my membership information and completed the payment.

On my first day in vivo, the 'v' logo on my dress really amazed my colleagues.

□ Technical challenges

The robot assistant requires cloud computing and AI to support large amounts of data interactions and computing services, which will require future networks to provide reliable connections and high-speed data transfers, as well as sufficient data traffic at an appropriate cost.

In order to provide intimate services, robot shopping guides need reasonable use of personal data, corresponding laws and regulations and technical means to achieve privacy protection, so that people can enjoy the convenience brought by intelligence without any worries.

The magic fitting mirror is actually an AR device based on naked eye 3D display. The transmission of 360-degree realistic human body information with low delay requires a data rate of more than 100 Gbps.

Agile manufacturing needs to realize a fully connected smart factory process from ordering, custom tailoring, production, logistics to delivery. It is the basis for achieving low-cost customized clothes in 24-hours, which requires high network connectivity, high communication and computing capability and enhanced data security.

Functions such as face recognition, mobile phone based identification and automatic payment require a higher level of encryption and security.

Food

03

Food is the basic need of human beings. The development of society makes food gradually become a kind of culture. People's pursuit of better food including more nutritious, healthy, delicious and low-carbon food, innovative cooking methods, more diversified dietary and a more graceful dining environment is never-ending.

The United Nations (UN) Sustainable Development Goals for 2030 includes 'ending hunger, achieving food security, improving nutrition and promoting sustainable agriculture'[13]. Technological developments, including intelligent agriculture and a human health database[14], can provide humans an abundance of healthy and low-carbon foodstuffs, and help reduce food waste and improve physical and mental health by formulating scientific and personalized healthy diet plans.

In order to meet the demand for quick and convenient dining, the smart kitchen in the future will help people complete most of their cooking. At the same time, more and more virtual restaurants or cloud kitchens will emerge, with intelligent chef machines with knowledge of cooking skills, food safety, nutrition and health. These virtual restaurants or cloud kitchens can customize menus to meet the needs of different people for a healthy diet. Technology and big data will become a highlight of future restaurants. Through multiple interactions with customers, service robots will continuously learn to provide more targeted catering services. Restaurants can improve the dining environment and atmosphere to enrich the dining experience of customers[15].

Future Food Farm

■ Scene description

My father works in the Academy of Agricultural Sciences (AAS). Recently, AAS is working with other agricultural production entities to form a Green Agriculture Production Alliance to solve some common agricultural problems[16]. Based on different types of crops and growing environments, the alliance has established different types of 'smart farms', to grow traditional soil-cultivated crops and hydroponics crops in vertical farms, water farms, rooftop farms, etc.[17] The combination of multiple agricultural models ensures that a variety of crops can be planted in the four seasons of the whole year, increasing the yield of crops, and greatly improving the utilization of land.

Intelligent Environmental Control System (IECS) using the environment sensing technology and remote monitoring technology continuously monitors the planting environments and collects real-time data on soil moisture, temperature, humidity, wind speed and sunlight. IECS can analyze the growth status of crops at different stages to achieve precise fertilization to ensure the quality of crops, reduce waste of fertilizer and minimize the damage to the natural resources including soil and water, etc.[18] Thanks to drone technology, AI-based image recognition and 6G mobile communication systems, IECS can accurately identify crop diseases and insect pests, choose the most environment friendly pesticides and complete pesticide spraying by drones.

Through smart devices like smart phones, customers can visit smart farms online anytime and anywhere, monitor the growth of crops, and buy vegetables, fruits and other fresh ingredients online. A 24-hour robot can efficiently complete the harvesting, packaging and delivery of the crops[19], ensuring that fresh food ingredients can reach the dining table as quickly as possible.

With the advancement of ICT, farmers can complete more than 80% farm work by operating a smartphone, which greatly reduces their workload, improves crop yield and quality, and promotes the sustainable development of natural ecosystems.

□ Technical challenges

To realize the smart farm, future networks needs to provide large-scale coverage and connectivity, precise positioning, and high-speed data transmission.

In addition to high-speed data transmission, intelligent management of crop growth process, pest management by image recognition, harvesting by robot require high-speed data transmission and AI capabilities.

Quantified Healthy Diet

■ Scene description

When I woke up on Monday morning, I stretched. 'Morning, Cong.' Cong, the household robot, came into my bedroom, turned on the screen, and started to recommend today's customized healthy breakfast. Based on the family's dietary preferences, health status, physical parameters and the nutritional content of the food they have consumed in the past week, the 'health manager' gives the family members different quantified nutritional meal recommendations. After that, the household robot contacted the smart kitchen to prepare our breakfast.

For my overweight father, Cong recommended 250ml of fresh low-fat milk, 100g of rice and 200g of fresh seasonal vegetables, all of which can be delivered within 5 minutes; for my mother who suffered from lactose intolerance, the Smart Chef Machine prepared special yogurt but not milk. Smart chef machine not only masters the cooking skills, which can prepare a feast at home, but also has rich knowledge of nutrition and health, and can make innovative dishes to ensure a healthy diet and special taste. For my fitness needs, Cong recommended high-protein steaks and fresh fruits and vegetables grown in the 'Balcony Vegetable Garden' (see Case 25). They are colorful, nutritious and delicious. After receiving the confirmation, Cong contacted the smart kitchen and assisted the smart chef machine to quickly prepare the breakfast. The way of quantified customized diet can meet nutritional needs and effectively reduce food waste. Low-carbon daily diet is the trend after 2030[20].

At 11 o'clock at night, I finally finished my work and walked out of my room. Cong came up to me and said, 'Would you like a snack?' I nodded. Based on the information from the wearable device that monitored my current physical and mental state, the data from my daily eating habits, and high-quality restaurants and dishes near home, Cong ordered for me 300g of millet gruel with goji berries and fish fillets. It is very helpful to replenish vitamins and quality protein and to minimize the damage of staying up late. At this time, the room automatically switched to sleep mode, I relaxed my body. After 10 minutes, the smart phone vibrated, reminding me that the drone has put the delivery in the courier cabinet on the window. The courier cabinet is a storage box that can extend out the window to receive goods from delivery drones of most logistics companies. In 2030, this multi-functional courier cabinet will be equipped by nearly every home.

□ Technical challenges

The popularization of household robots requires the continued development of machinery, AI and communication capabilities.

To quantify a healthy diet requires not only secure access to large amounts of personal health data information, but also AI responsible for personal health management.

Drone delivery in urban areas requires three-dimensional coverage, precise positioning, reliable communication and policy and regulations.

The Taste of Love

■ Scene description

Last weekend, Mr. Six invited me for a dinner. It was our first date. At 7 pm, I arrived at the restaurant on time by autonomous vehicle. Mr. Six came to me and held my hand, and we walked into the restaurant together. Mr. Six's household robot made us a reservation for outdoor seating on the 36th floor of this popular restaurant. The food looks exquisite and delicious, and the location was with a fantastic dreamlike view of the city at night. The Digital Taste Bud[21], 'Oral Patch' automatically records a full taste and sends to my smart phone for storage. It's a best-selling smart membrane, as transparent and thin as a mouth ulcer patch, without any strange feeling in the mouth. It can not only record the digitalized taste, but also stimulate the taste buds, and support near field communication with a smart phone.

Today, I would like to recall the memory of the 'Taste of Love'. The smartphone transmits the stored digital taste to the household robot. After receiving the data, Cong identified and ordered the target ingredients. The smart chef can use the ingredients to cook a meal that tastes almost identical. As I chewed the food, the digital taste buds 'oral patch' enhanced and repaired the taste stimulation, making the food taste just as what I remembered.

□ Technical challenges

Digital taste buds 'Oral Patch' is a kind of extremely thin and light intelligent terminal, and it need to communicate with other devices with nearly zero power consumption.

Similar to codec of voice, image and video, a digital coding method for taste is to be further studied and standardized. The digitalized encoding for smell and touch also needs further study to support full sensory 6G communication.

Housing

04

In the future, people will pursue more comfortable, convenient, environmentally friendly and safety living quality[22]. With increased of production efficiency, people will have more leisure time to regain the social attributes of the community that have been gradually lost in recent years due to the fast-paced life. More leisure time will make the neighborhood relationship more harmonious. The development of ICT will allow people to return to the warm home.

The houses in 2030+ include a variety of eco-friendly home appliances. Almost every family has a 24-hour household robot. Robots can help us to finish over 80% of the housework, they can also communicate emotionally with humans. They can collaborate with smart home devices[23] to provide 24-hour intelligent housekeeping services and reduce the carbon footprint of the home.

With the help of communication, positioning, AI, VR and other technologies, smart community in 2030+ provides public space and interactive places for residents. The social ways with integrated virtual and reality are more likely to break down the emotional barriers between people, and bring harmony to the neighborhood.

Smart Homes 2.0

■ Scene description

In 2030, the smart homes have evolved into the smart homes 2.0 era. After getting married, my husband, Six and I moved into a high-tech smart house equipped with smart homes 2.0. My parents let me take the robot Cong, who had taken care of us for years, to our new home. With a few simple steps, Cong quickly became the 'leader' of all the smart home appliances in the new house.

With a soft music alarm clock going off, the smart windows brightened, letting in a ray of sunlight. Six and I opened our eyes and got up. 'Good morning, Cong.' Cong, the household robot, came in to recommend a customized breakfast and briefed us on today's weather and schedule. Once the breakfast was confirmed, Cong collaborated with the smart kitchen for a quick breakfast preparation. The room automatically adjusted from sleep mode to comfortable morning exercise mode. The smart wallpaper slowly showed a forest effect, the bedroom screen switched to early morning yoga. The smart stereo played soothing music and the sound of birds chirping was heard from time to time, and the smart air conditioner switched to a comfortable morning exercise temperature and humidity. Six put on his smart running shoes and AR glasses, set me as a virtual running mate, and went jogging with 'me' in the community garden.

After yoga, I went to the bathroom. The bathroom light can automatically light up when it senses someone enters the bathroom. Knowing that I often take a shower after exercise, the water heater automatically switched to the right temperature. Cong helped put the clean bathrobe and other items neatly in the bathroom in advance. During the shower, it put news of the day on the bathroom mirror and activated the oral-broadcast mode.

In the dining room, Cong had already prepared a nutritious breakfast. When we were having the meal, Cong put Six's office computer into his briefcase, and took out his leather shoes from intelligent shoe cabinet.

After breakfast, Cong reminded me that I needed to meet an important client in the morning. Cong opened the intelligent wardrobe. After receiving the information, the intelligent wardrobe chose some suitable suits and presented them on the fitting mirror. I selected one and the smart wardrobe automatically rotated and pushed out clothes. The fitting mirror transmitted data to the bathroom beauty makeup mirror and mobile phones automatically. Mobile phone 'makeup' private function can consider my personal characteristics, skin condition, as well as the workplace environment, clothing collocation, beauty makeup trend, give today's custom makeup advice, and display final looks and each step instruction onto the beauty makeup mirror. I followed the instruction and finished my makeup quickly. Thanks to Cong, when I went downstairs, the pre-booked autonomous vehicle was waiting for me.

After leaving home, the door control will lock automatically and the room will switch to unmanned mode. Intelligent equipment such as lights and air conditioners will turn off automatically. The household robot cooperates with the other smart home appliances to start busy housekeeping tasks[24]. The intelligent vacuum cleaner is responsible for house cleaning. Smart garbage cans are busy in garbage recycling. The intelligent chef machine connects to the refrigerator for food inspection, and some food materials are ordered and purchased by the household robot. If I have time, I can turn on my mobile phone at any time to see the hot working scene at home. After everything is done, the household robot always gives me a housekeeping briefing and some photos of the neat room. The budget for food purchase I authorized is 300 RMB per day. If the budget is exceeded, he would send me the shopping list through the mobile phone and ask for my confirmation to proceed to purchase.

□ Technical challenges

Working in conjunction with a variety of smart home devices, the household robot can do almost all of the housekeeping tasks, which requires a network with large connections and the ability to communicate at high data rates.

The household robot can perform a variety of multifunctional complex services. This is challenging for mechanical and material technologies, and it requires a powerful cloud computing and AI capabilities.

7
CASE

Make Yourself at Home

■ Scene description

On Friday afternoon, I got the message that my parents were coming over for the weekend. It was the first time they had come since we had moved to the new house. I uploaded my parents' photos to the community service center in advance to ensure they could get through the community visitor gate successfully. Through my phone, I saw a live video from the community's public data center as my parents had entered the community and were taking an autonomous shuttle to my apartment. At the same time, I activated the guest mode of Cong through the mobile phone. Cong prepared for the guest's arrival, turned on the air conditioning, water purification, humidification and other smart appliances, started a comfortable home state, prepared fruits and drinks. It can also listen to some of the instructions from the guest.

Opening the door, Cong recognized my parents at a glance. When I got home, Cong was chatting with them. My parents were surprised by so much fun Cong had chatting with them. And Cong even told them some 'embarrassing' stories about my married life. Although it was their first visit since I moved, and I wasn't home, my parents were very satisfied with the convenience of the community and Cong's warmth.

My parents, who are always reluctant to spend money for themselves, were impressed by Cong. They asked me to buy another robot for them immediately. The system detected my second purchase and suggested that I could set the relationship between the two robots to provide better services. After I set up the family relationship, Cong soon transmitted the relevant cognitive data of my parents to the new household robot, Hui. By setting up family relationships, they can often interact as necessarily to provide better service to all of us.

□ Technical challenges

Humanized abilities of household robots require long-term training in the network, including long-term collaborative training and federated learning between similar and related robots.

Smart access control, community autonomous shuttle, household robot and mobile phone work together in virtually unattended scenarios. This requires data and knowledge sharing among smart devices. Traffic models and communication requirements among robots are distinct from those traditional human-to-human communications.

Harmonious Community 2.0

■ Scene description

In order to accompany my parents, I put on my VR device and remotely participated in the weekly community meeting at home. Community meeting usually involved discussing and deciding on community public affairs, arrangements of public activities, knowledge sharing of popular science, and so on. Participation in community public affairs is conductive to fostering a sense of community, increasing opportunities for social interactions, and enhancing neighborhood relations[25].

We can remotely participate with the help of VR technology, interact with the presence in the virtual meeting room of the community. Surprisingly, the new 'find friends' function was added to the conference assistant system. When I entered the conference, the system matched me with a close neighbor friend and arranged us to sit together so as to facilitate discussion and chatting.

The same technology of combining virtual and live participation is also used in many scenes. I am often present on community benches, watching children play together in community playgrounds, imagining what my baby in pregnancy will look like when he or she grows up. I am often sitting next to some young mothers, sometimes with virtual holograms of them. In this way I have made many new friends, other parents who are with their children, and I am able to ask them for parenting tips, discuss the latest trends, etc.

If a person living alone does not want to eat alone, he can choose the community public dining hall, or virtual projection of himself to a dining hall, to share meals with familiar neighbors. During the summer nights when there is a live football match, the community cafeteria will be extremely hot, and everyone will watch the game together virtually or in reality. Some people are in the living room and others are in the dining hall, but all of them are immersed in the

thrilling match and cheer together. The wonderful live 'bullet subtitles' (Danmu in Chinese) and the live hurrah, add a lot of fun to the game. Community libraries, cafes, playgrounds, and senior centers, which also have online and offline functions and are also good places for resident communication. Smart Community 2.0 is not only digital, but also warm.

□ Technical challenges

Community public space with online and offline integration increases the convenience of for people to participate in public affairs, requires VR/AR technology and smooth transmission of holographic images. It puts forward extremely high requirements on the communication data rate, strong AI capability, and precise synchronization.

Transportation

05

Automobiles, airplanes, ships and other modern means of transportation have greatly expanded the range of human activities. But the resulting traffic accidents, urban traffic jams and other problems also plague people. People are looking forward to better experience of the future travel such as zero traffic accidents, convenient and smooth traffic, etc.[26]

In 2030 and beyond, autonomous driving, Intelligent Transportation System (ITS) and ride-sharing will gradually mature and become commercially available. It will completely change the way people travel and improve travel efficiency[27]. Driving may become a professional sport for very few people. In future, the popularity of autonomous-driving car sharing and the convenience of urban public transportation will make most families give up buying private cars. As a result, the vehicle utilization will be increased, the traffic accidents and the parking needs will be greatly reduced, and the traffic congestion problems in cities can be effectively addressed.

In addition to urban traffic, long-distance travel will be more convenient and comfortable. In the future, the network will allow multiple transport sectors to exchange information promptly and safely, so as to realize the seamless connection and transfer of various means of transportation tools. Long-distance travel is no longer tiring, but enjoyable with beautiful scenery.

Smart City Traffic

■ Scene description

On our first wedding anniversary, Cong reminded Six, 'Today is a special day. Remember?' 'Oh, it is great!' A smile appeared on Six's face. 'Make restaurant reservations, please.' Taking information about diners, food preferences and restaurant recommendations into account, Cong quickly responded: 'a meal for two,' City Sky' revolving restaurant at 6 p.m., window seats.' 'Great.'

At 5:43 p.m., Cong reminded us that the ride-sharing driverless car would arrive in two minutes. We got in the car and the journey was relaxed and pleasant, nobody else was in the car because Cong selected the private ride mode. The car was connected to the city's transport network in real time and chose the best route. It would take us 10 minutes for 8 km.

After two years of testing and training, the city's intelligent transportation system has just comprehensively implemented a new function of no stopping at crossroad. Based on the precise positioning and real-time coordination between vehicle to vehicle and vehicle to pedestrian, when automated vehicles drive to a crossroad, they adjust the speed appropriately to avoid each other and pass through the crossroad safely and smoothly. This exciting new function would further reduce the city's average morning commute time from 30 minutes to 20 minutes. When passing the first crossroad, I initially scared in the car before it entered first crossroads, but soon I felt relaxed as it was very smooth and safe.

We arrived at the restaurant on time. After we got out of the car, the car automatically completed the payment, then it immediately set off to pick up the next passenger nearby.

□ Technical challenges

To ensure safety, there is a high demand for collaboration between driverless vehicles, vehicles and roads, vehicles and pedestrian. To achieve this collaboration, precise positioning, extremely high communication reliability, extremely low latency and sophisticated AI capabilities are required.

Intelligent transportation system (ITS) requires the big connectivity capabilities of IoT, as well as big data communication capabilities.

Smart Journey Arrangement

■ Scene description

Before getting off work, I was informed that I need to have a business trip to city A 500 miles away for an urgent and important meeting tomorrow. I unlocked my smart phone and said, 'I will attend a meeting at Company X in city A at 9 a.m. tomorrow and go back home at 5 p.m. Please help me plan my trip.' Soon, a round-trip plane ticket was booked for me, and the 'travel assistant' know me well and had helped me to select a window seat on the plane. The ride-sharing car to the airport was booked at the correct time.

The next morning, when I got up at 6 o'clock, Cong had already got my luggage ready. At 6:58 Cong reminded me that the ride-sharing autonomous car would arrive in 2 minutes. I always promote low-carbon and environment-friendly life. It is easy to match the shared travel with multiple people when I go to the airport in the morning. The smart travel assistant had cleverly helped me to book autonomous car using carpool ride mode. In 2030, to promote low-carbon travel, the intelligent transportation system will automatically identify carpooling with more than three passengers and allow it to enter the dedicated fast lane of airport highway and many other city roads. Similar as the unmanned airport shuttle, the car can pass through non-stop security gates at airports. And the latest security inspection system is capable of instantly scanning the passengers and luggage for security check. Since all vehicles entering and leaving the airport are automatic drive and operated by the system, precise time control can be achieved. Check in 40 minutes ahead of schedule has become history. Thanks to the autonomous vehicle and non-stop security inspection, we only need to arrive at the boarding gate five minutes before takeoff.

I arrived at the boarding gate at 7:25 a.m., and took the 7:30 flight. On the plane, I updated meeting materials and

sent it to the colleagues in Company X. I landed at 8:30 a.m. As soon as I got off the plane, more than 10 autonomous vehicles were waiting at the airport. My smart phone indicated the car it had booked for me. After facial recognition, I got into the car and left the airport quickly together with four other passengers. I arrived at the conference room of Company X at 9 o'clock. I selected the 'luggage to home' service, so my baggage was delivered to the gate of Company X by a special cargo van at the same time.

At 7 o'clock in the evening, I was at home and having a delicious dinner with Six. In the future, one day round-trip for 500 miles will become a reality by seamlessly connecting multiple means of transportation, and it will greatly reduce overall travelling time.

□ Technical challenges

The intelligent travel arrangement system needs the evolvement of artificial intelligence technology, as well as real-time data sharing, which raises a need of information encryption and security.

The entry of autonomous vehicles into airports puts forward higher requirements for communication reliability, network security and anti-hacker attacks.

The realization of services such as not stopping at the security inspection gate, baggage delivery service at the airport, and autonomous vehicles at the boarding gate needs to break the barriers of different administrative sectors and realize the seamless interconnection of data and information.

Learning

06

Learning, as the process of acquiring knowledge, skills and cognition, accompanies people throughout their lives. As a method of education assessment, examinations have been used for thousands of years. As society progresses, it is believed that exam-oriented education brings about various disadvantages. In the future, with the help of human brain science and information technology, people hope to abolish exams, change the learning assessment system, and reshape the learning process.

In the digital world of 2030+, based on computing technologies, big data, communication technologies, and brain cognition, digital brain and learning models are established for each person after birth. The outcomes of learning and the knowledge level will get an accurate assessment within the learning process. Without examinations, every child will have a happier childhood with an enjoyable learning experience. As the engineer of the human soul, teachers will pay more attention to the character and personality shaping of each child. Teaching progress will focus on the interest, cultivation, learning abilities and habits. And the routine teaching work is handed over to 'intelligent teaching assistants'. Parents will no longer feel anxious about the child's learning and future career. With the help of the education assessment system, parents have a clear cognition to the child's interests and hobbies, learning ability, mental development and personality traits[28]. Most parents will not be busy in taking their children to have remedial classes. They are more willing to accompany children growing up together, and the parent-child relationship gets harmonious.

With the evolvement of mobile internet, AI, AR/VR/XR, holography and other technologies, intelligent education system will break the constraints of space, time and age, make the distribution of educational resources and the education chance more equitable. AR/VR device assisted education becomes popular, and artificial intelligence will change students' learning fashion. There is no need to spend time on learn by memorization, and creative learning will become popular. The immersive and intelligent learning experience brought by AR/VR can effectively stimulate students' interest in learning, and greatly improve the efficiency of learning.

One Happy Day at School

■ Scene description

On August 1, 2036, after two-week summer vacation, students went back to school. In 2030+, as the teaching process is more interesting and practical, which integrates a lot of field practice and social practice, the traditional teaching in the classroom is greatly reduced. Students will have more fun to go to school than to stay at home. Both summer and winter vacations are shortened to two weeks every year in China (Currently, there are about 8 weeks' summer vacation and 4 weeks' winter vacation).

My son had prepared his schoolbag without any books, but full of gifts for the classmates. These gifts are bought from his travel to Japan. The smart watch reminded him that the school bus will arrive in two minutes. After he ran downstairs and got on the school bus, I could see my son on the bus through the smart phone.

As for the history course, my son is assigned to class C this semester. The key of class C is training students' interest in history. The teacher asked everyone to wear AR glasses where the historical scenes were recreated. Students could talk with historical characters, ask them their feelings when historical events happened.

His classmate Lily hurt herself in the summer vacation, so she had to stay at home and remotely access the class through AR. During the group discussion, my son put on his AR glasses, and saw 'Lily' sitting next to him and some classmates argued enthusiastically about whether the First Emperor of the Qin Dynasty was a good king or not. On the class students pick up pens and write directly on the electronic screen of the smart desk to answer the questions. All digital textbooks are stored in the smart desk, so students can go to school without paper books. During the class, the intelligent desk recorded the whole learning process in class, and provided the learning assessment and analysis of each student's performance in every class to their parents and teachers.

At 5:30 p.m., my son came back from school. It is necessary to strengthen the knowledge through homework. The smart school desk is connected with the 'smart desk' at home. And specific homework tasks of different children are directly delivered to their 'smart desk' at home. The desk lamp was always on until the homework was finished. In order to enhance parent-child interaction, some homework is required to be jointly completed by both parent and student. With the facial recognition, if parents were not involved in the process, the homework cannot be started and submitted. To develop the capability of solving problems independently, students need to complete some homework on their own. Parents' participation will be prohibited by the smart desk. Furthermore, some homework is designed to build collaboration skills in children. AR glasses are needed to connect several students' desks within the team, and the cooperative homework needs to be displayed on electronic screens for the students of the same team simultaneously.

After the homework was submitted, based on the quality of the homework and the whole-day evaluation, the 'intelligent teaching assistant' gave my son some interesting practice games to further consolidate learning. Finally, at 6:30 p.m., all daily homework was completed. My son and his friends played together in the community garden after dinner.

□ Technical challenges

Intelligent classroom introduces holographic, AR/VR and other teaching tools to support the remote classroom, which has a high demand for data rate.

After identification, students are ready to log into the personal learning system through classroom desks and family desk, to carry out reading, assignments, and collaborative learning activities and so on. The desk, along with the background in the whole process of the system is beneficial to students learning evaluation and assessment.

To build such system, capabilities of communication, AI and cloud computing, and a high degree of information security on communications are required.

Teaching assessment system and 'intelligent teaching assistant' need to combine human brain science and learning process cognition to establish personal learning big data, carry out targeted assessment and learning guidance. This puts forward high demand for communication, data and AI technologies.

Insects Detective

■ Scene description

After the reform of the summer and winter vacations, the school has increased the number of outdoor practice courses. Today's biology lesson theme was insect exploration, and the teacher will spend the day leading the students in a field lesson. For my son, this was his favorite lesson because he is curious about nature.

Arriving at the Forest Park by school bus, the teacher divided the students into four groups of eight students each, my son was very happy to be elected as a group leader. The morning task was 'insect detective' competition. Everybody needs to wear AR glasses, working in groups, and look for different insects within a pre-defined area in the park. Teachers will receive a reminder if any student is out of the pre-defined area, and AR glasses will remind the student to go back into the pre-defined area. Parents can see their children's position and state at any time through the smart phone. Each group needs to take pictures with AR glasses, get the information of the insect online, and create a 'digital' insect specimen together. A selected person is responsible to present the activities and results of each group. The ranking score for each group is based on insect quantity, specimen quality and the level of interpretation.

My son organized the team members to search separate area. Some were in charge of lawns, some were in charge of the stream, some were in charge of shrubs, and some were in charge of trees and trunks, to find any insect. My son was responsible for identifying insects from the photos taken by his group, collecting insect's information online, and making a digital specimen. AR glasses are convenient for taking and sharing photos of insects with the group. The camera automatically adjusts its focus according to the focus of the human eye. In order to prevent students from getting separated and lost, if any group member is beyond

the set distance of 200 meters, the geographical location will be displayed in the AR glasses and sent to the group leader and the teacher.

Two hours later, my son and his group completed their task. They found 20 kinds of insects including 3 kinds of spiders, 1 kind of ladybeetle, 4 kinds of wild bees, and so on. Through gesture control of the AR glasses, my son put the insects into different categories, and made a very good digital specimen. At noon, the teacher and all students sat around on the lawn, enjoying the nutritious lunch just delivered by the school drone, and sharing the achievements of each group with keen pleasure. A small drone nearby was recording the beautiful moment and directly sent the live video to their parents.

□ Technical challenges

Precise positioning is an important technique to ensure the safety of large-scale outdoor education.

AR glasses supporting camera and recognition should be connected to the network. Therefore, the AR glasses should be lightweight and 'power consumption friendly'.

"I'm a Speaker"

■ Scene description

After 10 years with the company, the vice president (VP) of HR informed me that I was being promoted to general manager of the brand department.

I realized that my speech ability was not good enough. As the person in charge of the brand department, I have to make speeches on various occasions, and my skills of public speaking needs to be improved quickly.

My husband, Six recommended me the latest 'I am a Speaker' APP. It ran on AR glasses with a large number of speech fragments, which gave me a lot of immersive speech skills training.

After choosing a topic, I put on the AR glasses and the APP created a virtual speech scene full of audiences, and the front row audience is my boss and important clients. It was useful for me to practice to overcome my nervousness for making a presentation. What's more, the AR glasses have another function of eliminating the audience, when you were making a speech to the real audience. After I finished my speech, I switched to the normal mode and heard the enthusiastic applause and praise from the audience, which made me feel more confident in speaking.

Based on the AI system and brain-computer interface (BCI), this APP can also comprehensively score the speech level in the practice process, and the brain computer test results will give me the 'nervousness measurement'. In addition, it can point out the flaws in my presentation and mark out the parts that need repeated training and further improvement.

After more than 20 training sessions of simulated and real audience elimination with 5 topics, 'I am a Speaker' APP gave me a speech score of 95 points, close to the level of a senior speaker. A month later, I was on stage for the first time. I made a successful speech in front of 2,000 people at the launch event.

□ Technical challenges

AR assisted learning will become the most popular method to improve learning skills in 2030s. The rendering of VR scenes needs to match the timely speech content, and the timely intelligent speech evaluation system puts forward high requirements on the data rate and AI capabilities.

Work

07

Work is not just a means of earning a living in the modern world, it is a way to achieve self-worth. Work is one of the most important parts of our lives. In the future, people will be more inclined to engage in creative work, prefer a more liberal work mode, and pursue to maximize the value of their knowledge and capability.

In 2030+, holographic and multi-sensory communication will realize multi-person interaction remotely in real time. Application scenarios including collaborative work, interactive meeting, social interaction, remote control, etc., will completely break the limitations of the fixed workplace and realize mobile social networks and mobile office[29]. The new generation of AI will be widely used in many industries and fields, releasing people from the repetitive, high-risk and high-precision work[30]. With the help of automation office tools and intelligent project assistant tools, a large number of people of fixed job will become freelancers, who are no longer employed in one company, but able to choose different tasks or projects from different companies based on their abilities and expertise[31].

Flexible Work Mode

■ Scene description

My younger brother majored in electronic games in university. In order to gain more practical experience, college students have installed the 'united products' platform and become one of the registered partners. At ''united products', some people will release the concept of the products, attract and recruit the professionals needed to jointly complete the development and launch of the product. Young people prefer this kind of free and community-oriented job mode. They are no longer employed by traditional enterprises, but with a group of like-minded partners in the 'united products', where new style companies are product-oriented, and the corresponding rewards are obtained after the products are launched to the market.

After breakfast, my brother switched the room to 'work' state. His AI secretary started a holographic conference call to the research team in San Francisco. When the conference call was switched on, a live hologram of my brother appeared in their conference room, and my brother saw a hologram of them sitting together. All the model and data in the technical discussion appeared in front of all the people in the meeting simultaneously. The desk was a touch screen, and all the meeting members could jointly edit the data in real time. The AI secretary took the meeting minutes synchronously.

After hanging up the conference call, my brother remotely checked the latest result of project at the R&D center in San Diego and in Shenzhen. Smart devices can collect data in real time, which can be quickly integrated and analyzed by the AI system and output results[32]. He was pleased with the results. The project has been 75% completed and is expected to be completed this week. Now it is the time to launch his new game project on the platform that he has been thinking about for nearly one year.

□ Technical challenges

'United products' needs to build a team for product research and design, and to support remote collaboration. This raises a demand for integrated development systems and tools, communication, and AI.

15 CASE

Smart Office

■ Scene description

Today is Tuesday, the day I choose to work in the office. Telecommuting becomes more and more popular, and most companies choose to telecommute on Mondays, Wednesdays and Fridays, and office work on Tuesdays and Thursdays. My company has nearly 5,000 employees in the city. Besides the headquarters, the company has a total of 4,000 employees in 50 'shared offices' distributed throughout the city, which ensures that every employee can go to office within a 3-kilometers distance. It not only provides an efficient and fast morning and evening commute, but also satisfies the needs to work together with colleagues.

The weather was fine. After breakfast, I walked 15 minutes to the shared office. The robot receptionist has received my appointment information in advance. Identified by face, the robot receptionist guided me to the work area. After greeting my colleagues, I scanned my face at a digital desk and logged into the office system of my company.

The AI secretary has arranged today's work in order of importance and urgency, and displayed them on the desktop. At 9:00 a.m., I needed to report the product planning to VP. The AI secretary has connected the video conference system, and the material for discussion appeared on the screens of my VP desk and my desk. During our discussion, the AI secretary was revising the product plan simultaneously. At the end of the meeting, the confirmed revised product plan had been sent to the relevant colleagues. I told the AI secretary that I planned to organize a team building this weekend. After a while, two team-building options and relevant participation information have been provided. I chose one from the two plans. The AI secretary contacted the travel agency, organized the follow-up matters of the team building, and informed all members of the department about the team-building plan.

□ Technical challenges

Distributed office needs to provide immersive experience and not affect collaborative experience and work efficiency. This requires high data rate and low latency of communication system.

AI secretary can complete a lot of workflow and interactive work, which requires the continuous evolvement of AI.

16 CASE

Smart Industries

■ Scene description

The changes in society and people's life are great in the last 10 years. Holographic 3D advertising has replaced electronic screen and other forms of traditional advertising. Through face recognition, the advertisement of products that I am interested in appeared on the screen at the entrance of the store. The convenience store is already unattended, restocked regularly by robots, and face recognition-based payment becomes popular. Patrols in the streets have also been replaced by smart police robots, and the robots connect all the smart surveillance cameras in their region of responsibility in real time. The robots can respond automatically, quickly identify criminals and arrest them. The robots of the police station can be on duty 24 hours a day. Through the image processing capability, AI can clearly describe the portrait of the criminal suspect, and help the police to solve crimes in a short time. The robot in the hospital is responsible for registration, consulting service, automatic medicine delivery, electronic medical record management and other routine work in hospital. The robots in banking, insurance and other industries can be responsible for answering questions online 24 hours a day, product customization and recommendation, data management, automatic claim settlement[33], etc., which greatly improve service efficiency and customer satisfaction. 6G and AI will have a profound impact on thousands of industries, changing every aspect of people's work and life.

□ Technical challenges

Society embraces high-speed connectivity, rich digitalization and intelligence. This will create huge demands for communication, computing and data, as well as secure interconnectivity among systems.

Entertainment

08

The continuing evolution of science and technology will greatly increase people's work efficiency; thus, people could have more leisure time enriching their spiritual world. In the future, holographic and full-sensory movies and games will bring people immersive interactive experience, enhance emotional engagement and obtain nearly real entertainment experience. AI can fully meet people's personalized and customized entertainment needs.

VR/AR/ XR, and other motion-sensing interactive devices[34], will change people's cognition and interact with the digital world, to improve users' real experience[35,36]. With the development of multi-sensory, AI intelligent recognition and other technologies, people in 2030 may be able to experience touch, smell and other feelings in a digital way. For example, in the immersive virtual seaside scene, you can sail in winds and experience the cool feeling of clothes being immersed from the cold sea. You can also lie on the beach for sunbathing. Along with the sound of waves, the birds, and the laughing from children playing on the beach, you can smell the sea breeze. People's entertainment will become richer and more convenient in the future. They can not only start a thrilling adventure while lying on the sofa, but also go back to the Renaissance era and fall in love with Romeo, or virtually join the Chinese Women's Volleyball Team to compete for the 2031 Women's Volleyball World Cup.

Mars Exploration

■ Scene description

After exploring Venus, my teammates and I were setting off for the next stop, Mars. This was the latest space exploration cloud game. The game was stored in the cloud and can be played immediately without downloading the APP. With the help of various advanced game equipment of cloud technology, virtual games provided nearly real experience through full-sensory immersive fashion. Although our teammates came from different countries with different languages, cloud translation helped us overcome the language barrier and enjoy a real-time communication experience.

Through the dusty atmosphere layer, we landed on the Martian surface with ''Tianwen 5' spacecraft. I heard my teammates breathe a sigh of relief, 'Guys, put on your space suits and we'll leave for the international space station on Mars in three minutes.' After opening the hatch, my teammates and I slowly walked away from Tianwen 5 and completed a mission-- walk on Mars. Through the fully-surrounded body sensing suite, I felt the touch of stepping on the ground, hard and steadfast. I see the real Mars, the reddish-brown dry land, all kinds of mountains, and the gully valleys filled with dust from the sandstorm. The distant sky is yellowish-brown. I bent and picked up a small stone, and it was heavy with tough and dry surface. Compared to the earth, the weightlessness of Mars made me stagger on the bumpy road. I even heard my breathing and the sound of wind. When I get closer to the space station, I heard more chaotic noises including people's talking, machines running, the roar of Mars rovers. Lots of people passed me, greeting me warmly. In the afternoon, we would take the Mars rover to the flag-planting point 3 kilometers away, and finish the flag-planting task of each station. Then there would be all kinds of geological exploration and scientific research tasks for us to complete.

□ Technical challenges

Full-sensory immersive games require the support of intelligent terminals with rich human-computer interfaces, as well as high-quality game graphics. The requirement for data rate is up to Gbps.

Stars and Fans

■ Scene description

My son has been a fan of variety shows and idols since he was a child. He likes attending fan meetings, concerts, autograph and other activities. Last week, he participated in a fan meeting and brought a smart device-- Smart AR glasses for fans. These glasses support real-time delivery of the latest news of your favorite idols. For those idols who have a busy schedule, the professional AI team has developed a new function of 'holographic idol', which can be used to realize one-to-one chatting, singing and dancing between idols and thousands of fans.

The Glory of Tang Dynasty

■ Scene description

After 2030, people have realized the dream of traveling around the world or traveling through history without leaving home. Digital travel is becoming more and more popular. Through immersive holographic space and multi-sensor smart glasses, people can virtually travel through the historical scene and experience the living history.

On the weekend, my husband and I came to the ancient city of Xi'an for a tour. Wearing the AR glasses, you can automatically see the restored historical scenes and the reality at some specific locations. I saw the endless stream of pedestrians and horses on the street and the magnificent palace in the distance. I also saw the bustling scene of foreign merchants trading in Chang'an City. I can hear the sound of selling on the street. I can taste the unique waffle, grilled mutton, cheese cherry and other food on the digital palate, and feel the prosperity of the Tang Dynasty.

When coming to the Big Wild Goose Pagoda, we happened to meet Master Xuanzang in Hongfu Temple. Walking in Furong Garden, we would suddenly meet the famous poet Li Bai, who was drinking and composing poems with his friends. To my surprise, Li Bai found us and invited us to recite poems together. In Huaqing Pool, I saw Li Longji and Yang Guifei enjoying the wine and dancing together.

Taking after me, my son likes Jay Chou too. The smart device automatically made an order for Jay Chou's 40th anniversary digital concert. Thanks to the smart home theater system and technologies such as holographic technology and ultra-high-definition video streaming, we could enjoy an immersive concert experience at home. We were excited and prepared a big package of snacks in advance. At 7:50 p.m., the living room switched to concerts mode and automatically turned on the sound insulation mode and enhance the sound reflection effect. We sat on the smart sofa and prepared to enjoy the immersive digital concert. The holographic projection of our friends appeared beside us. The concert began at 8 o'clock, we could see fans waving their 40th anniversary customized glow sticks and shouting 'Jay, Jay'. On stage, neon lights flickered at multiple angles, and dancers floated and soared through lasers. In front of the stage, with constantly jets of fireworks, dressed in a leather vest, Jay Chou singed the familiar song 'Nun Chucks'. In the exciting atmosphere, my son couldn't help but stood up in the holographic scene and sang.

After the concerts, with excitement, we simultaneously entered into the virtual interaction of 'holographic idol'. 'Jay' sat in front of us, said hello to us and answered our questions. At last, we were invited to sing 'Rice Fragrance' together again. My son and I were all immersed in the happiness of singing together with 'Jay'.

□ Technical challenges

Virtual holographic stars based on AI can interact with thousands of fans one to one. In order to achieve real experience, AI and communication capabilities need to be continuously improved.

□ Technical challenges

AR technology makes tourism immersive and full of culture. The smooth and immersive experience of AR puts forward higher requirements for terminal display and communications.

Medical Treatment

09

In some areas of China, there is shortage of quality medical resources. In some regions, being difficult and expensive to see a doctor, lack of trust between doctors and patients are the main problems today. Thanks to large-scale connectivity, high-speed access, improved AI capabilities and medical digitization, online diagnosis and treatment will be expected to complete the treatment of most common diseases after 2030. The popularization of telemedicine, tele-surgery, robotic nursing and other intelligent medical treatment has improved the medical efficiency[37] and alleviated the imbalance regional distribution and shortage of medical resources.

With the ability of health information acquisition and precise positioning of smart terminals and wearable devices, and the introduction of AI technology, the epidemic disease prevention and control system after 2030 will link data from all parties, including personal health, anti-epidemic agencies, hospitals, emergency services, and communities. Thus, it can enable to identify the risk of epidemic diseases at the first time, and minimize the possibility of a major epidemic outbreak through precise prevention and control and scientific treatment.

One-stop Online Clinic

■ Scene description

Thanks to the development of online diagnosis and treatment platforms, in 2030, we will be able to get professional medical treatment and access to high quality global medical resources at home. The government-certified intelligent online medical platform is authorized to connect to the patient's online health advisor system, and integrates hospitals, doctors, patients, pharmaceutical companies, medical insurance institutions, etc. Based on AI technology with online primary diagnosis and triage functions, most common diseases can be diagnosed and treated online and medication can be purchased online. Doctors on the platform are professionally certified and have rich experience.

I had allergic reactions in my nose for the last few days, so I opened the online diagnosis and treatment APP, and agreed to authorize the APP to access the relevant historical data in my personal health consultant system. This APP is a must-have APP for everyone in 2030, just like a family doctor. The APP discovered that I've been having sneezing symptoms for the last few days. It was autumn, based on the trajectory of my activities, the system queried the pollen concentrations in the active areas monitored by the health department. I was initially diagnosed with allergic rhinitis. Then, the system automatically generated a questionnaire related to my condition. After I quickly completed the questionnaire, the system made a preliminary assessment and matched me with an ENT (ear, nose and throat) doctor.

In two minutes, the APP connected me to a video call with the assigned ENT doctor. After an exchange of medical history, the doctor gave me guidance to have a remote check. I removed the detachable camera from my phone and put the camera to my nasal cavity. The doctor remotely manipulated my camera to complete a detailed examination, and then diagnosed me with aller-

gic rhinitis. According to the examination results, the doctor issued the prescription. I needed to pay attention to the nasal care. I need not write the prescription down, because my phone would synchronize all the messages with the family health manager (an intelligent health management robot, refer to Case 23 for details). After the doctor issued the prescription, I selected the default online drug purchase and paid for it automatically. The system showed that it would be delivered by drone in 20 minutes.

From opening the online medical APP to finish the drug purchase, the whole process is completed within 30 minutes. In 2030 and beyond, everyone is used to this online medical diagnosis and treatment platform. While the physical hospitals only solve the difficult cases which need to be inspected or treated by large-scale or professional medical equipment.

Although everyone has many wearable devices and their health indicator detection ability and accuracy have reached the medical level, the diagnosis and treatment of some diseases require relatively professional examine equipment or operating instruments. At this time, the online diagnosis and treatment platform will recommend me to the nearest community clinic cabin. In 2030 and beyond, there will be one such multi-functional community clinic cabin for every 1,000 people, which is unattended, assisted by robots nurses. People can enter this room by scanning their faces when their appointment time comes. Every four weeks, my son went to the community's clinic cabin, lying on a dental operating table, and the doctor remotely completed orthodontic treatment. In some important public events and gatherings, as well as busy markets, autonomous vehicles carrying similar clinic cabin will be deployed to the scene around the event to meet people's urgent

medical needs at the first opportunity.

The online diagnosis platform, or one-stop online clinic, can provide one-stop solution for patients[38]. In the meanwhile, cooperating with the unmanned community clinic cabin, more than 90% of disease diagnosis and treatment can be done by doctors remotely. This not only improves the efficiency and satisfaction of patients, avoiding cross infection in hospitals, but also effectively alleviates the pressure of the overload hospital operations.

□ Technical challenges

The one-stop online clinic for remote online diagnosis and treatment needs to break down the barriers of platform, hospital, individual, medical insurance institutions, drug sales and drug delivery, to ensure the security and traceability of the medical process. This requires cross-departmental data sharing, communication capability and information security.

Intelligent community clinic cabin, mobile diagnosis and treatment vehicle, etc. need to complete the timely transmission of ultra-high definition medical images, remote dental treatment and other fine operations. This has high requirements for the bandwidth and latency of communications. Autonomous vehicle clinics and robot services have high requirements for AI capabilities.

Digital Twin based Diagnosis and Treatment

■ Scene description

With the popularity of digital twin in the medical industry, doctors in 2030 and beyond will not only be able to monitor their patients' physical indicators in real time, but also to conduct remote diagnosis, treatment and surgery. To realize the digital twin, a digital model of real patients needs to be built, and the digital model need to be updated timely through the sensors and medical examination. By simulating the functioning of the human body, physicians can diagnose illnesses, predict the possible disease, and adopt treatment plans to improve the quality of life[39].

The desensitization medication prescribed by the online treatment system last week alleviated the symptoms of rhinitis, but I prefer traditional Chinese medicine. My friend recommended an old Chinese medicine doctor to me, who is experienced in treating rhinitis. The old expert cannot come to the clinic for medical treatment these days because he travelled to the Mount Huashan. I went to his clinic and put my arm into a machine. My pulse information would be collected and transmitted by a sensor to a twin arm in front of the doctor in real time. The duplication of the pulse is almost 100% as the original one. With the help of holographic image, digital multi-sensory information and other advanced technical information, the remote diagnosis of traditional Chinese medicine has been realized.

After feeling my pulse, the doctor identified I was phlegm-dampness constitution and needed acupuncture and Chinese medicine treatment. I lay down on a 'smart traditional Chinese medicine bed', and soon my virtual twin body was presented to the expert. He gave the virtual twin body acupuncture, and the mechanical arm on the smart bed gave me acupuncture accordingly and accurately. A similar 'smart traditional Chinese medicine bed' is very popular, which supports remote acupuncture, bone-setting and massage. Most elderly people purchased the smart bed. With the help of connection and AI, the smart bed can timely monitor the physical parameters of the elderly people. The preset program of the bed can realize some professional

nursing functions such as massage and medicine feeding, etc. In case of emergencies, the bed can intelligently contact Emergency Services, and take artificial respiration and other rescue measures.

□ Technical challenges

Digital twin of a part of the human body requires high reliability and low latency for sensing and communication.

Digital twin based diagnosis and treatment require precise positioning, low delay communication and precise time synchronization.

Smart traditional Chinese medicine bed need to be connected to medical professional organizations and requires high AI and communication capabilities.

Micro-robot Surgery

■ Scene description

Medical devices and technologies are improving in 2030 and beyond. With the advanced MRI (magnetic resonance imaging), all examination data can be obtained through a one-time scanning and simultaneously uploaded to the patient's digital medical record. This makes it easy for doctors to review at any time, while saving the patient's time for examination. The 3D printing technology has already matured, and the damaged organs, human tissues, skin, blood vessels, bone or ligament, can be biological-3D printed.

My father has insomnia, chest tightness and dizziness recently. I decided to take him to the hospital for a thorough examination. After examination, the doctor told us that my father suffered from arteriosclerosis, and suggested an invasive vascular surgery, including the dredging of the diseased parts and vascular bypass. After completing the modeling of the vascular system by CT scan, the doctor quickly determined the specific location of the lesion, and the 3D printerquickly prints endovascular vessel based on vascular data from lesions. He carefully

reviewed my father's vascular data model and planned the procedure in detail. After local anesthesia to my father, the doctor injected a sub-millimeter micro-robot into the blood vessel[40], and then guided the micro-robot to enter the diseased part through touch-screen operation to perform the vasodilation and replace the inner wall vessel of the blood vessel. The surgery lasted only 10 minutes, and after 2 hours' observation, I could take my father home if all goes well.

□ Technical challenges

Micro-robots entering the human body for minimally invasive surgery puts forward extreme demands on its size and power consumption.

To operate robots to perform meticulous surgeries, ultra-low latency, such as end-to-end latency of less than 1ms, is required.

Healthcare

10

People's awareness of health is getting stronger and stronger, and health management evolves from reactive improvement to proactive prevention. It includes daily health management, disease prevention and rehabilitation care[41], etc.

In 2030 and beyond, many people wear more accurate and professional intelligent wearable devices. These devices can timely capture hundreds of people's health index of related parameters. With the help of AI system, complete professional health management advices are given[42], including dietary, micronutrient supplementation, fitness plan and mental health, etc.

Family Healthcare

■ Scene description

A few years ago, National Health Bureau promoted a free intelligent health assistant software that adapts to most of wearable devices. Hundreds of individual health indicators are obtained through smart watches, wrist traps, rings, intelligent insoles/belt/hat etc. These indicators are analyzed and diagnosed by the health management system of a professional medical organization, which is responsible for user health management with the help of a household robot. I installed this software, and wearable smart devices monitor my body status in real time and feeds back to the software for health management and analysis. Based on the biological test results, it gives me suggestions on diet adjustment, exercise advice, etc. Those functions help me manage my daily health and maintain the best condition[43]. Later on, I strongly recommended to my parents to install this software. In case of sudden onset, the intelligent health assistant software can automatically react to take first aid measures and notify the hospital and me simultaneously.

With the proliferation of AI and 6G communication, the smart health assistant software was upgraded to a trusted AI health manager. The health manager can give early warning of common diseases, provide preventive suggestions, and take timely preventive treatment measures, so that diseases can be detected and treated early to improve the quality of people's life.

Every spring I used to have hay fever symptoms, sneezing and itching all over my body. But now I'm completely free of hay fever. According to the regional pollen concentration, pollen type and the changes of physical data indicators, the smart health manager will remind me that the blooming season is coming. To avoid allergens, I should wear a breathable smart mask and multi-functional glasses when going out. In the meantime, the health manager will help to adjust the diet structure, avoid allergy food, and recommend anti-allergic medication.

For my parents with chronic diseases, the health manager can analyze the collected data on daily diet, medication use, exercise, and authorize the connection to the hospital data center. The doctor will reconfirm the details and give timely guidelines to the health manager for my parents to improve diet structure, adjust the regimen or arrange medicine, targeted training plan and supervise to ensure the best results.

□ Technical challenges

Proactive health planning by health managers requires the development of sensing, AI and human health medicine, as well as the improvement of network connectivity and data sharing capability.

Soul Mate

■ Scene description

The health manager is not only an intelligent robot, but also my soul mate. It has an intelligent mood management system that enables user data monitoring through brain-computer interfaces and other wearable devices. Thus, it can sense changes in user mood in real time and deliver positive feelings to users through intelligent emotional interactions to alleviate and eliminate negative emotions. It's used to detect early signs of depression disorder in patients[44].

Today, the statistics showed a decline in the department's performance, the VP criticized me and I was feeling down. When I got home, the health manager sensed my frustration and began to play relaxing music to relieve my depression. It asked Cong to help me relax with a shoulder rub. Meanwhile, Cong told a few jokes, which made me laugh and I instantly forgot my troubles at work. It also encouraged me to adopt proactive behaviors like exercise to relieve stress.

The health manager is not only my soul mate, but also an intimate companion to accompany my family. Through machine learning, intelligent health manager can gradually learn the mental health status of different family members, so as to adopt different ways of interaction and communication to take care of my families[45]. When there is no one at home with my mom, the health manager will chat with her, and even talk about the latest TV series together. It also tells stories and jokes to the little baby. The human-machine partnership in 2030 will be deeper and richer than ever before[46].

□ Technical challenges

A soul mate needs to have certain brain-computer interface ability to access human emotions. AI capabilities are needed to be further extended to the level of 'human thought' and thought-based robot and human communication.

Environment

11

The sustainable management of natural resources is essential for social and economic development. The United Nations has formulated the 2030 Sustainable Development Goals, which emphasize the protection and sustainable use of natural resources, including water, oceans, land and forests and so on, through the provision of sustainable modern energy services and urgent action to address climate change and its impacts[47]. Governments should establish an intelligent ecological environment supervision system, formulate and improve environmental management system, and build a sustainable ecological chain of environmental protection industries.

With the powerful connectivity of communication systems and intelligent systems, the monitoring and protection of the environment in 2030 will be more accurate and effective. People should make full use of the scientific and technological advantages to reduce industrial emissions, the consumption and waste of natural resources. People should adopt the environmentally friendly technology to optimize the industrial development and resource use, promote the sustainable and efficient use of natural resources, and protect biodiversity and the ecological environment, to minimize the influence of human activities on the global climate[48].

Balcony Vegetable Garden

■ Scene description

My father's daily job at Academy of Agricultural Science (AAS) is to genetically engineer crop seeds with the help of AI. The improved seeds are not only environmentally resilient and high-yielding, but also are high in quality and nutritional value. His colleague, Yang, is responsible for developing safe fertilizers that are rich in nutrients and free of chemical additives. Yang and my father are known as 'golden partners'. Recently, their joint project 'Balcony Vegetable Garden' has gained popularity among urban families.

The 'Balcony Vegetable Garden' APP is connected with the intelligent system to remotely monitor and control the intelligent vegetable or flower pots. Based on the location of pots, balcony orientation, floor height and other information, the 'Balcony Vegetable Garden' APP can recommend suitable crops and corresponding soil composition and fertilizers to users. The recommendation takes the current season, physical indicators of users and their families into account. After users purchased pots, seeds and related services online, background intelligent system will guide planting. After that, the system monitors the planting environment of the pots and collects data in real-time, such as temperature, humidity and sunlight. It analyzes thegrowth of the plant in different stages and provides automatic watering, fertilizing, temperature and humidity control, to ensure optimal growth of crops. Upon the observation of the abnormal growth environment, AI technology can adjust the balcony's temperature and humidity factors, without damaging the home environment, while promoting the optimal growth of crops. 'Balcony Vegetable Garden' is like a distributed food synthesizer, which is expected to meet more than 50% of the future family needs of vegetables and fruits. It can produce more fresh vegetables and fruits, reduce the consumption of land resources.

□ Technical challenges

The 'balcony vegetable garden' requires high connectivity, precise positioning, broadband transmission of future network, and agricultural AI capabilities.

Green New Life

■ Scene description

In 2030, with the help of broadband communications, high connectivity, and AI, every home will have a carbon account that keeps track of total household carbon emissions. There will be a monthly carbon emission quota based on household size, and a tiered cleaning fee will be charged for the excess carbon emission. For unused carbon emission quota, we can buy and sell it freely on the public blockchain based carbon index market. This makes people pay more attention to the emission reduction behaviors.

A distributed solar energy generation and storage system has been installed on the south balcony. With this system, our home can reduce a lot of electricity consumption, and the surplus electricity can be shared and metered for negative carbon emissions. Smart home devices can track the daily needs by learning the behavior of family members, provide automatic control of temperature and humidity. They are equipped with exclusive environmental guidelines for people to save energy and reduce emissions in their daily lives, and have the function of carbon emission statistics. The whole smart home system becomes an intelligent environmental protection system, monitoring energy consumption in real time, providing carbon emission data, and synchronizing to the carbon emission app. For example, the household smart garbage bin can not only distinguish and classify the garbage, but also realize the crushing and degradation of the garbage. For non-bio-degradable waste, hazardous waste, etc., the smart garbage bin can calculate the relevant carbon emissions of the waste. The community's 3D printing booth can classify and recycle common and easily recyclable materials, convert them into different printing materials, and give corresponding carbon emission rewards to users. In addition, for some goods ordered online, users can choose to make them in small 3D printing booth, which will generate very low carbon emissions.

In order to implement ecological and environmental protection, individual environmental behaviors have been included in the personal credit system. The carbon emission management system will record all bad behaviors such as damaging the environment or wasting resources. Bad environment credit will affect many aspects of life and work. Therefore, people will pay extra attention to their environmental protection behavior in their daily life. For example, when shopping, more and more people are willing to choose low-carbon products. Carbon emission value has also become an important index that must be marked on the package of products, which drives enterprises to implement low-carbon manufacturing and adopt low-carbon product packaging.

□ Technical challenges

Household carbon emission management requires communication systems to improve intelligent sensing, precise positioning capabilities for accurate measurement and statistics of carbon metrics.

Safety

12

In 2030, people will focus more on safety. The incidental natural disasters and man-made accidents may bring huge casualties, property losses and post-disaster psychological trauma to people and the society.

Based on enhanced broadband mobile communications, AI analysis and digital twin simulation, more effective early warning of natural disasters will be possible in 2030 to comprehensively assess risk levels, improve disaster response measurements and reduce losses caused by disasters. When disasters inevitably occur, digital means can improve the efficiency of emergency evacuation, help people to escape from the disasters in prime time. Through timely rescue, people's lives and safety can be guaranteed to the greatest extent.

Fire Escape

■ **Scene description**

Today is the Fire Prevention Day, the fire department organized a community activity to carry out fire control knowledge popularization, and distributed the fire escape masks to every household for free, and provided a live demonstration of the proper use.

The fire escape mask is made of the most advanced fire-resistant material, which protects people by isolating the head from heat. In addition, the advanced filtration materials can effectively filter harmful gases mixed in the air, ensuring a clean air supply during evacuation. The most attractive feature is that the mask includes an AR glasses that connected to the network, hence the fire department can wake it up on demand in an emergency.

When a user wears the mask, AR will generate the optimized escape route based on the user location, the surrounding environment, and the situation of fire. Even if when the smoke is very thick and the user can see nothing,

AR glasses can play a clear perspective and guide the escape route. The user can smoothly evacuate to a safe place quickly. In order to improve the efficiency of fire rescue, intelligent fire escape masks will periodically broadcast their specific positions. The fire rescue system can accurately obtain the distribution of people on site, provide detailed rescue plans, and guide firemen to carry out effective search and rescue with the help of AR glasses.

□ **Technical challenges**

The AR escape mask has high demand on the positioning function in complex scenarios. In addition, the timely escape guidance, field vision in dark and smoky environments have a high requirement on the communication data rate.

Emergency Capsule

■ Scene description

If you don't have time to get out of your home in time for an earthquake, your home's smart wardrobe may be a good temporary shelter. I have purchased a smart wardrobe with a shelter function. Each corner of the smart wardrobe has a sturdy, thump-proof space that can be used as an earthquake escape capsule. In case of earthquake, the buffer protection around the escape capsule will pop out to protect the cabin from the thump, to protect the people inside.

In case of disaster, it not only protects the human body from collision and extrusion, but also sends distress signal with positioning information. The built-in battery is sufficient to support communication for more than 120 hours, allowing rescuers or robots to precisely locate and rescue the people inside. When the terrestrial communications network breaks down, the capsule can periodically send a distress signal via satellite communication. In addition, the capsule is capable of periodically detecting 'search and rescue' signals, which is a new 6G short-distance communication mechanism, and the range is generally within several hundreds of meters. Once the 'search and rescue' signals which are broadcasted by the rescue devices or rescue robots are received, the escape capsule will automatically send feedback to report its detail position.

What's more, the intelligent escape capsule is able to read the physiological state of the people inside the capsule, give him comfort and encouragement. The escape capsule can provide water and nutrients to support life requirement of 120 hours. And these foods will be automatically supplied at the appropriate time based on the physiological state of the people inside the escape capsule.

With its indestructible shell, terrestrial and satellite access, short-range rescue signal communication, and 120-hour of human energy supply, the escape capsule can let people inside be safe and be successfully rescued with nearly 100% probability.

□ Technical challenges

Accurate positioning of the escape capsule, low-power communication, and intelligent supply are all critical to ensuring that lives be protected and rescued.

Earthquake Search and Rescue

■ Scene description

Just now, my mobile phone received the latest alarm that a magnitude 7.0 earthquake just struck City A one second ago, which is 500 miles away. It is expected that the wave will reach my place 15 seconds later, but the earthquake wave would get weak and there was no need to worry. People turned on their mobile phones or putting on their AR glasses to watch on-the-spot report of the earthquake.

In City A, an alarm message was broadcasted 10 seconds before the quake hit. The city's Emergency Relief Center activated the red emergency preparedness one second after the alarm. However, due to the high magnitude of the quake, it still caused casualties and large property damage. The quake cut off 80 percent of the terrestrial network coverage, but the satellite network remained running. 100 base stations cited on drone from the emergency center arrived in the corresponding air area within one minute. A temporary emergency communication network was successfully deployed to provide communication services.

The first feedback was the positions of the 5,000 trapped people and other rescue related information. The city Emergency Relief Center decided to immediately perform a search and rescue activity for these people. In the meantime, most of the injured people on the ground received remote assistance guidance from the emergency medical centers in City B, C and D. The injured people were given initial treatment such as wound packing and moved to a safe area to await the arrival of ambulances.

The Earthquake Prediction Center predicted that there are four aftershocks in the next hour, the second of which will occur 10 minutes later with a magnitude of 6.0. The Emergency Relief Center decided to use unmanned methods to rescue the serious injuries. The King-Kong rescue fleet (unmanned) equipped with drones, autonomous vehicles and robots sets off into the stricken area.

After the strongest aftershock, rescue experts, firefighters and medical personnel entered the stricken area. They began to search for the trapped or buried people. In front of a collapsed six-story building with steel-concrete structure, after fire trucks sent out 'search and rescue' signals, all the escape capsule of the trapped people within 200 meters gave feedback with their precise positioning information. Rescue psychologists provided psychological counseling through voice contact of the rescue capsule. After scanning the structure of the collapsed building, the first step was for rescue robots to drill in and pull out some people. After that, AI system gave the best mining and cutting rescue plan, guide the cutting robot to dig and cutting rescue.

About two hours later, after repeated life probes, it was confirmed that there were no signs of life in the building. The rescue team moved to the next building.

□ Technical challenges

The prediction of natural disasters such as earthquake is constantly advancing, requiring the continuous improvement and enhancement of big data and AI.

Rapid networking in emergency situations requires high degree of flexibility in communication system design.

Satellite communications can guarantee basic communications in disaster scenarios and are crucial when terrestrial communications are damaged.

Equipment and applications such as emergency rescue systems, emergency rescue vehicles, unmanned rescue vehicles, unmanned rescue, remote first aid guidance, rescue robots, etc., all have a high requirement for communication data rate and connectivity capability.

Summary

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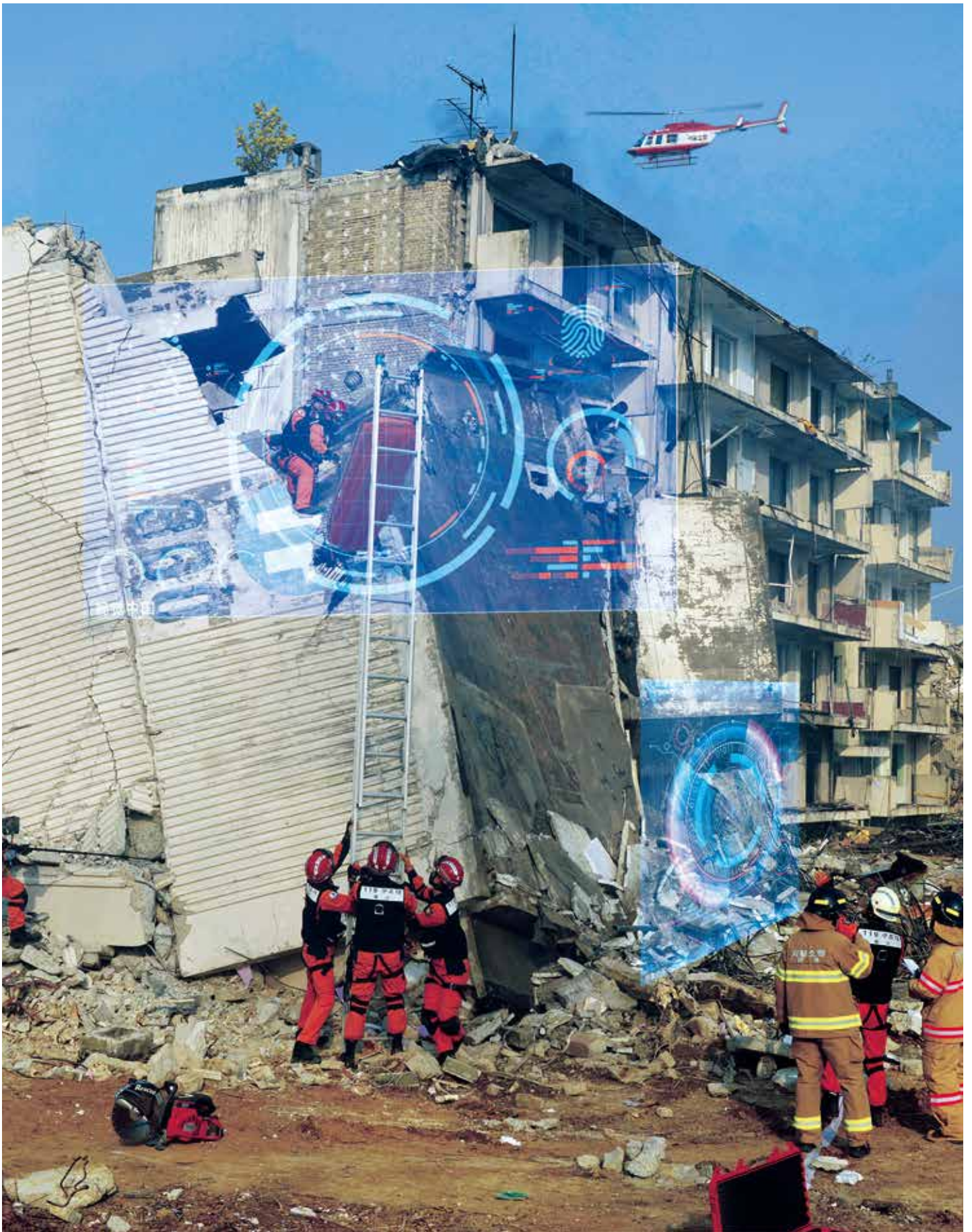
In 2030 and beyond, people will pay more attention to functional and personalized apparel, delicious and nutritious diet, convenient and harmonious residential environment, and convenient and fast transportation.

Regarding medical treatment and healthcare, advanced equipment and medical techniques, such as intelligent body status monitoring devices, in cooperation with remote diagnosis and treatment, will make people well protected and live a longer and happier life.

Regarding entertainment, immersive entertainment experience sponsored by advanced techniques such as full-sensory rich media, XR enhanced gaming, will bring people unparalleled experience than ever before. People's spiritual world will be further enriched.

Regarding work and study, the AI, XR, and other advanced techniques, will reshape the education system and bring a brand-new education style. The children will enjoy a happier learning experience and grow healthy. The work efficiency will be further improved with the advances of technologies. Released from the burden of work, we will have more time to engage in creative works, so as to better realize our self-worth.

Regarding environment and safety, we should protect the earth we live, and respect every life on the planet. We must take actions to ensure a sustainable development of the society. The advances of science and technology promotes an eco-friendly life style and consciousness of green and low-carbon.

In future, enhanced connectivity, ubiquitous digitization and powerful intelligence will build a freely connected physical and digital world, which brings us a better digital life in 2030+.

Abbreviations

3D	Three-Dimension
AAS	Academy of Agricultural Science
AI	Artificial Intelligence
AR	Augmented Reality
BCI	Brain-computer Interface
ENT	Ear, Nose and Throat
ICT	Information and Communication Technologies
IT	Information Technologies
ITS	Intelligent Transportation System
HR	Human Resources
MR	Mixed Reality
MRI	Magnetic Resonance Imaging
PR	Public Relationship
TCM	Traditional Chinese Medicine
UAV	Unmanned Aerial Vehicle
VP	Vice President
VR	Virtual Reality
XR	Extended Reality

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