Research on the Human-Computer Interaction Design in Mobile Phones

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***Abstract*—Mobile phones play an important role in our modern life. Meanwhile, the development of human-computer interaction has promoted the progress of the mobile phone industry. A good human-computer interaction design model needs to consider the user's understanding of the product system, but also needs to use ergonomics and cognitive psychology to carry out in-depth analysis and research on the user. The emergence of mobile communications and cloud computing technologies has also changed people's lifestyles. Firstly, through the discussion and research on the relationship between human-computer interaction and ergonomics and cognitive psychology, some key points that human-computer interaction design can influence the development trend of mobile phones are proposed. This article will also point out the impact of communication technology and cloud computing technology on mobile phones and people's lifestyles. Besides, the different operating systems of mobile phones will be compared and analyzed. Due to the different human-computer interaction experience in different user groups, the different requirements of them on a mobile phone will be analyzed. At the same time, the article also pays attention to the social problems caused by people's over-reliance on mobile phones. Finally, this article will make a reasonable prediction of the future development trend of mobile phones.**

Keywords—smart phones, human-computer interaction, mobile communication, cloud computing, user experience

I. INTRODUCTION

There is a significant role of smartphones in human lives. In 2020, the number of people with smartphones is estimated to be more than 3.5 billion in the world, which means 45.04% of the world's population owns a smartphone [1]. The successful design and technological progress of each product cannot be separated from the development of interaction design, which is increasingly closely related to people's lifestyles and life quality. Smartphones are used for a variety of purposes by people from all walks of life. Most people spend their time in environments with many computerized devices [2]. Human-computer interaction (HCI) is a field of research and practice that appeared in the early 1980s. It was originally a professional field of computer science, covering cognitive science and human factor engineering [3]. Interaction design has been widely used in industrial design and human-computer interaction. Human-computer interaction focus on the design of computer technology, which is a multidisciplinary field of study and is the interaction between people and computers [4]. The fields involved in human-computer interaction include computer and information science (information systems, software engineering, artificial intelligence), behavioral science (cognitive science, cognitive psychology, sociology, organizational psychology, social psychology), etc [5]. With the continuous development of science and technology, the Internet and communication technology are used in life, which provides convenience for people's work, life, communication and entertainment, and other activities. The goals of interaction design can be measured from two perspectives: usability goals and user experience goals. The goal of usability is that users can use interactive products succinctly and bring convenience to users. It improves and enhances the user's interaction with the product, allowing users to have a better experience in work, study, and life. The user experience goal refers to the subjective feeling of describing the interaction between the user and the system. With the advancement and development of social civilization, interactive design is increasingly focusing on the design of people with different needs, including people with disabilities, the elderly, children, and so on. Meanwhile, there are many social problems caused by mobile phones, such as teenagers addicted to playing mobile games, personal information leaked from the phone.

II. HUMAN-COMPUTER INTERACTION

A. Human-computer interaction design and ergonomics

Human-computer interaction design is a discipline that studies the communication or operation modes between humans and machines (or systems). To better adapt the machine to people, product designers must first fully understand the human body. Only when they have a good understanding of the stretchability and range of activities of their bodies can product designers use their design to design products or systems, so that the designed products or systems can be better used by people. Ergonomics (or human factors) is a scientific discipline that involves understanding the interaction between humans and other elements of the system, and applying theory, principles, data, and methods to design, which ultimately optimizes human well-being and the overall professional system performance [6]. Ergonomics was valued during the Second World War, during

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which various aircraft, tanks, firearms, and ships were produced to achieve better coordination between the human body, machinery, and environment [7]. Science and technology incorporate ergonomic principles to achieve more effective and accurate operation of the soldiers who are using the equipment and they are not prone to fatigue during long hours of work.

Now ergonomics is also widely used in mobile phones. On the one hand, product designers need to consider whether users are comfortable when using it, whether they are prone to fatigue, and whether this mobile phone design can be easily used by everyone with different palm sizes. On the other hand, product designers need to think from the perspective of human-computer interaction design whether these ergonomic designs can provide users with a good human-machine communication experience, whether they are simple, intuitive, natural and comfortable when used.

B. *Human-Computer Interaction Design And Cognitive Psychology*

Cognitive psychology mainly studies the high-level psychological processes of human beings, focusing on the advances in attention, memory, language processing, perception, problem-solving, and thinking [8]. In the mid-1950s, cognitive psychology became very important. Several important factors here:

- Dissatisfaction with the behaviorist approach because it only emphasizes external behavior, not internal processes.
- Develop better experimental methods.
- Comparison of information processing between humans and computers. It mainly grasps the process of undetectable mental activities by studying the input and output of human beings [9].

Since the research on cognition constitutes the mainline of cognitive psychology, people usually define information processing psychology as narrow cognitive psychology. The process of human cognition is a process of cognition, and also a process of processing and responding to external information and outputting accordingly. The process of people seeing, hearing, smelling, and touching is perception, which is accepted by the human body through the stimulation of images, sounds, smells, etc. and abstractly encoded one by one. Next, the human brain will compare and analyze the received information with the information already stored in the memory, and explain the previously obtained stimuli, and this process from receiving to concluding is cognition [10]. Human-computer interaction design in mobile phones aims to improve the user experience of using them. Product designers should try to use eye-catching text or images to attract users' attention. Later, they can make full use of various software inside the mobile phone to give the users a perceptual stimulation, such as pictures, videos, sounds, or vibrations. After the user has fully received the perceptual information, they will analyze and remember it in their mind. Meanwhile, the interface in cellphone designed by product designers needs to be simple and comprehensible. From the expression of tasks and information to various operations, the model should be kept as consistent as possible, which simplifies the user's difficulty in understanding their memory, and also makes the user psychologically have a better recognition of the system and interface.

III. MOBILE PHONES

A. *The mobile networks and cloud computing*

A 3G network (using WCDMA) is a single-frequency broadband network, which means that each 3G mobile unit operates on the same broadband frequency and interferes with each other and surrounding units. Therefore, the signal-to-noise ratio (SNR) proved to be an important factor. At the same time, it should also be considered that the business area of the 3G cell should increase the advantages of the cell and reduce overlap and interference to achieve the theoretical maximum of data transmission rate, performance, and quality. The indoor system has its 3G unit to meet the needs of buildings, factories, or other industrial facilities. The delay time of these networks is about 100-500 ms, and the maximum download speed theoretically achievable with this technology is 42 Mbps [11].

4G communication technology does not deviate from the previous communication technology. Nevertheless, it is based on traditional communication technology and uses some new communication technology to continuously improve the network efficiency and function of wireless communication. The fourth-generation mobile networks will be an ultra-high-speed wireless network, an information superhighway that does not require cables. This new network allows mobile phone users to connect wirelessly to virtual reality in three dimensions, which can transmit high-quality video images. Its image transmission quality is comparable to that of high-definition TV. The system can be downloaded at a speed that is twice as fast as the current network and can meet the requirements of almost all users for wireless services.

The standardization process of the fifth-generation mobile network is currently in progress. All parties in the telecommunications market are cooperating closely, and the first version is expected to be released in 2020 [12]. The data transmission rate is estimated to be 10 to 20 Gbps for a user, which is combined with 3G and 4G cellular [13]. Compared with 4G, the complexity of 5G networks will also be reduced, and the energy used by 5G equipment batteries is expected to be 100 times that of 4G terminals [14]. With the advent of 5G, 5G mobile phones will bring the following changes to life:

- People can receive signals more quickly and steadily, even if they are in a crowded environment.
- Unlimited data plans may become the standard, which means people can connect to WIFI at any time and any place.
- People transfer videos with larger memory on their mobile phones as fast as transferring music files.
- People can have a better user experience on the app.

Cloud computing can change the way consumers, companies, and governments store information, how they process that information, and how they use computing power. It can also be an engine of innovation, a platform for entrepreneurship, and a driving force for corporate efficiency [15]. Mobile cloud

computing is a new platform that combines mobile devices and cloud computing to create new infrastructure, which provides rich computing resources to mobile users, network operators, and cloud computing providers. Cloud computing has opened up a new area of interaction. The powerful capabilities of cloud computing allow users to access their data anytime, anywhere. They can enjoy a variety of new network services and give users more space and capabilities in the information age. Cloud computing is the unified management and scheduling of a large number of computing resources connected by the network, forming a computing resource pool to serve users on demand. The cloud software platform in cloud computing uses application virtualization technology and has multiple functions such as software search, download, use, management, and backup. It can build software resources, software applications, and software service platforms and usage environments for users. Ultimately, it can improve the current way of acquiring and using software, so that users have a better experience when using mobile phones [16].

B. The Smartphone Operating System

Android is a semi-open source operating system based on Linux. Its kernel is based on the Linux system kernel, in addition to it is the middle class, database element, API interface, and application framework written in C or C++ voice. Generally, Android developers use the Java language to write applications. When these applications written based on Java database elements are run, the program code will be instantly converted into Dalvikdex-code (Dalvik Executable). The Android operating system will then run these programs through the dynamically compiled Dalvik virtual machine [17]. Due to the open-source nature of the Android system and the universality of the Java programming language, many third-party software development companies and many individual developers are very keen to develop Android applications.

The Windows Phone system is a touch-sensitive mobile device operating system made and released by Microsoft Corporation. Its predecessor was the Windows Mobile system, but on the new Windows Phone system, the mobile phone puts more emphasis on sociality. In Microsoft's human-computer interaction design, the Windows Phone system shows the user a new experience. Its main interface is composed of many squares, and each square can be customized by the user as a favorite application and function. And it provides horizontal and vertical two-dimensional extension, which is very different from the experience of other mobile operating systems [18].

In terms of human-computer interaction design, the Symbian system once led the other mobile phone systems in the keyboard era. Other new smartphones use a lot of efficient and convenient touch screen operations. Even Symbian systems have introduced many touch screen phones, but they have not fundamentally escaped the inertia brought by keyboard operations. In terms of human-computer interaction design, the Symbian system once led the other mobile phone systems in the keyboard era. Other new smartphones use a lot of efficient and convenient touch screen operations, even though the Symbian system has also launched many touch screen phones, but it has not fundamentally escaped the inertia brought by the keyboard operation. For example, a large number of indirect positioning technologies (such as software included under multiple layers of menus) make users feel cumbersome to use. Besides, product designers still follow the old-fashioned philosophy to design operating systems.

In terms of the concept of human-computer interaction design, the BlackBerry system focuses on creating efficient email and text message sending and receiving services. The BlackBerry has a large screen and provides users with an excellent full keyboard typing feel. At the same time, users are using the full keyboard to send and receive text messages very quickly. The design of the entire mobile phone is almost serving this purpose. Due to the large number of touch screen designs used in new smartphones, BlackBerry has also introduced several mobile phone designs with touch screens and full keyboards under pressure. Because the company's target user is busy businessmen, they insist on not giving up the input experience brought by the physical full keyboard. At the same time, it retains the full keyboard, which prevents the BlackBerry from having the large screen of other smartphones.

The iOS system architecture has four levels, namely the Core OS layer, the Core Services layer, the Media layer, and the Cocoa Touch layer. Due to the addition of the light touch layer, the iOS design concept emphasizes multi-touch direct operation. In human interaction design, iOS is more inclined to slide, click, drag, and squeeze compared to the traditional mobile phone keyboard operation. Besides, many sensors are built into the phone, which can be used as auxiliary input devices [19].

C. The Demand for Different User Groups On Mobile Phones

The mobile phone of businessman needs to help users complete communication accurately, quickly and smoothly, and can effectively assist users to complete various business activities. Businessmen here are presumed to have mid-level or higher positions in the company. They are busy with daily work and have a lot of business and deal with many copies of business secrets, and they may often travel on business. Therefore, the phone designed for businessman should have the following three characteristics: first, they must have good call quality and continuity of transmission and require strong signal reception capabilities, and they will not be inaccurate due to business trips; Secondly, a large number of emails and important documents need to be sent and received on the mobile phone, so the business mobile phone must be able to quickly send and receive emails and documents and ensure a high degree of security; Third, the mobile phone must have a powerful hardware configuration to ensure the needs of some mobile phones for office work, such as processing copy, tabulation, calculation, etc.

The main consumer force in the mobile phone market today is the youth group. The youth group here mainly refers to college students and young office workers who prefer to catch up with the trend and love new technologies. Their biggest feature is that they like to socialize online [20]. Due to they are eager to communicate and have a lot of free time, the vast majority of people who are active on major social networking sites (eg Facebook, Renren, Weibo) are youth groups. Therefore, mobile phones must have powerful social functions. Even if the system itself does not have such a function, many third-party software or applications are needed to meet these demands. Similarly, applications such as games, audio, and video are also favorites

of young mobile phone users. They are more likely to be able to easily add, purchase, and delete applications. Besides, they need a mobile phone system is entertaining, and the mobile phone shell can attract attention.

Since most elderly people are not as capable of accepting new things as young people, they are not able to operate well in front of these slightly more complicated new mobile phone operating systems. Older people seldom buy and download software like games that bring high profits to developers [21]. Therefore, due to their lack of purchasing power, there are not many options for mobile phones specifically designed for the elderly. They also have their special needs for human-computer interaction design experience. First, vision is often the biggest obstacle for the elderly. Larger buttons and display fonts are very necessary for the design of mobile phones. Secondly, the elderly usually only use mobile phones to make calls. Furthermore, the elderly are often equipped with mobile phones to prevent emergency incidents from being able to contact their families in time. Therefore, product designers need to focus on the usability of mobile phones.

Although mobile phone manufacturers have made great efforts in human-computer interaction design and user experience, their ultimate goal is gaining profit. Therefore, it is difficult to ask them to pay special attention to disabled people and tailor-made suitable mobile phones for them. However, developers of mobile phones and mobile application programs can design more diverse experiences of human-computer interaction, adding some methods such as voice input and prompts, shock prompts when receiving calls or feedback, and giving light prompt when receiving calls to meet the fundamental demand of the disabled in mobile phones.

D. The social problems caused by mobile phones

With the popularization and increasing functions of mobile phones, mobile phones seem to have become an indispensable part of modern people's lives. Due to excessive dependence on mobile phones, many people may suffer from "persistent local attention" and "mobile phone obsessive-compulsive disorder." It is found that if people are concentrated on work and study and are interrupted by phone or e-mail, it can take up to 15 minutes to reinvest. Many aspects of the lives of many people in the modern age are inseparable from mobile phones [22]. For example, people use the bus to watch the news and send text messages to pass the time. People use their mobile phones to watch electronic magazines and videos before going to bed to help fall asleep, and so on. This represents the progress of smartphones, but also seriously affects people's health.

With the popularization of 4G technology, more and more people use mobile phones to surf the Internet. While enjoying this convenience, people are also suffering from the potential threats brought by many mobile phones online, such as illegal information such as violence and pornography, as well as frauds used by scammers using mobile phones [23]. One issue that the country needs to take very seriously is how to ensure that people can enjoy the open and equal mobile phone network while protecting the legal rights of mobile phone users.

The large doses of electromagnetic waves generated by children's frequent use of mobile phones are not only harmful to children's growth and development but also bring diseases such as asthma and leukemia. Children are in the stage of growth and development, and the water content in body tissues is more abundant than adults. Because the microwave of the mobile phone has the characteristic of more damage to the organs with more water, the microwave is the most harmful to the human eye [24]. Also, long-term texting may cause the child's fingers to develop deformities. Besides, children playing games with their heads down for a long time will cause great harm to the children's cervical spine [25].

IV. Conclusion

The network in today's world is no longer a single information and communication network, but a multi-media high-speed network integrating voice, video, and consultation. As the two most important terminals for cloud computing in the future, the boundary between smartphones and personal computers will continue to blur, and mobile phones are bound to move towards the cloud. Eventually, it will become the most widely used and most important cloud computing device, and it will develop rapidly with communication technology and mobile phone hardware. The combination of 5G technology and cloud computing will be popularized in the future, which will open up a new area of interaction. The application of human-computer interaction design on mobile phone products will also be more valued by developers and manufacturers. At the same time, a more concise, natural, and efficient human-computer interaction experience will be the common pursuit of users and designers.

This article analyzes the relationship between human-computer interaction design and ergonomics and cognitive psychology. At the same time, it explains the impact of 5g technology and cloud computing on future life and analyzes the characteristics of different mobile phone operating systems. Besides, it analyzes the needs of different groups for mobile phones. Finally, people's over-reliance on mobile phones will harm themselves.

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