Application and Research of Using the Virtual Reality Technology to Realize the Remote Control

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Abstract

The concept of remote control comes from the inter-operation among the computers; whereas in the field of industrial control, the remote control can function on the workshop directly through the computer, to realize the monitoring over the production environment and the operation on the mechanical equipment. The virtual reality technology can vividly simulate the on-site situation in the digital form, thus brings a truer operating experience for the manager. And the data interchange between the virtual reality and the true site can be well resolved by the sensor.

Keywords: Virtual Reality, Internet of Things, Sensor, Remote Control

The virtual reality technology came into being at the beginning of the 80's of the 20th century, after over 30 years of development, the technology grows mature gradually, which has been widely applied in many fields such as urban planning, tourism landscape, medical science, military affairs, aerospace, indoor design, real estate development, industrial simulation and emergency deduction till now [1]. Viewed from the present application, the scopes where it is applied mostly belong to simulating a known environment or state, and when the existing conditions change, the virtual scene can not really and dynamically reflect the change of environment, unless you amend it. This is the result of the limit of Internet, so we can see that the virtual reality technology can only make the remote user simulate and experience the pre-set environment and state under the internet environment, in the other word, the environment that the user experiences is utterly simulated through the digital technology, and not the remote virtual experience of existing real environment, thus the virtual reality technology can not be applied in the remote control field---as it can not synchronize with the true environment, naturally not to mention "control". And in the age of internet of things, with the development and application of sensor technology, the virtual reality technology may break through this barrier and enter the remote control field [2].

1. Virtual Reality Technology

1.1. Brief of the Virtual Reality Technology

The Virtual Reality (Briefly called VR) is the high-tech that appeared during the recent years, it utilizes the computer to simulate a three-dimensional virtual world, provides the user with the visual, acoustic and tactile simulation, makes the user feel in the real world and observe the things within the three-dimensional space timely and without limit.

The "reality" in the virtual reality widely refers to any thing or environment existing in the world in the physical or functional sense, it can be realized in practice, or difficult to realize, or can not be realized at all. And "virtual" means computer-generated. Thus, the virtual reality refers to a special environment generated by the computer, a human being can use various special devices to "project" oneself into this environment, operate on and control the environment to realize a special aim, that is, the human being is the master of this kind of environment [3]. The virtual reality technology is related with computer graphics, human-computer interaction technology, sensor technology and artificial intelligence, etc. It uses the computer to generate the vivid three-dimensional visual, acoustic or olfactory sense, and makes the man experience and interact with the virtual world naturally through certain device as participant.

1.2. Birth of the Virtual Reality Technology and Its Features

1.2.1. Birth of the Virtual Reality Technology

As early as at the beginning of 60's, with the development of CAD technology, people started to study the computer system where the dimensional sound combines with the three-dimensional. In the 80's, Jaron Lanier presented the opinion of "virtual reality" VR, aiming at building a new user interface to make the user located in the three-dimensional data environment expressed by the computer, and "travel" in this environment by eyes, hands, ears or special three-dimensional device, to create a sense of "being on the scene".

The virtual reality is the environment where human beings visualize, operate on and truly interact with the sophisticated data by computer. Compared with the traditional human-computer interface (such as keyboard, mouse, graphics, user interface and the prevailing Windows, etc.), the virtual reality has realized a big leap in quality either in technology or in idea. The traditional human-computer interface regards the user and computer as 2 independent entities, regards the interface as the medium of information exchange, it is up to the user to input the demand or instruction into the computer, and then the computer will react on the information or controlled object[4]. Whereas the virtual reality regards the user and computer as an entity, visualizing the information by various tools, thus forms a vivid environment, and the user can be directly put in this three-dimensional information space to use all information freely and control the computer by this means.

1.2.2. Features of the Virtual Reality Technology

"3I" are the main features of virtual reality, and they are immersion, interaction and imagination.

The immersion, also called the sense on the scene, refers to the degree of reality that the user feels when he exists as hero in the virtual environment. The ideal virtual environment makes the user unable to discern between the true and the virtual, makes the user fully immersed into the three-dimensional virtual environment created by the computer; everything under this environment looks real, sounds real and acts real, even smells real and tastes real, the sense the same to that of the real world.

The interaction refers to the degree of operability of the object under the virtual environment and the degree of naturalness of obtaining feedback from the environment (including the instantaneity). For instance, the user can use the hand to catch the virtual object directly under the virtual environment, at this time, he will feel like grasping something and sense the weight of object, and visually the grasped object can move with the movement of hand instantly.

The imagination, stresses that the virtual reality technology possesses a wide imaginable space, which can widen the knowing scope of human beings, not only represent a truly existing environment, but also mentally construct a non-existing environment, even an impossible environment.

1.3 Analysis of the Virtual Reality System and Its Current Application

1.3.1. Brief of the Virtual Reality System

Generally speaking, a complete virtual reality system is composed of virtual environment, virtual environment processor with high-performance computer as core, visual system with helmet mounted display as core, acoustic system with voice discernment, sound composition and sound location as core, body position and posture following equipment with position tracker, data gloves and data coat as main parts, and gustatory, olfactory, tactile and force feedback systems.

1.3.2. Current Application of the Virtual Reality System

The virtual reality technology is a sort of high-level human-computer interaction technology by comprehensively employing various techniques to create a vivid artificial simulating environment and effectively simulating all behaviors of sensory systems of human beings under the natural environment; the virtual reality system is composed of many functional units, capable of simulating the environment difficult or impossible to build in the real world. At present, this system has been widely used in many fields including urban planning, tourism landscape, medical science, military affairs, aerospace, indoor design, real estate development, industrial simulation and emergency deduction, *etc*.

However, viewed from current situations, although the virtual reality can simulate the scenes existing in the real world or the scenes calculated scientifically by the human beings, it can not follow the dynamic change of certain scene. This is the result of the limit of internet, so we can see that the virtual reality technology can only make the remote user simulate or experience the environment or state pre-set, in the other word, the environment that the user may experience is totally simulated by digital technology, and not a remote virtual experience of existing real environment, which results in the fact that the virtual reality technology can not be applied in the remote control field---as it fails to synchronize with the real world, certainly not to mention the "control" [5]. In an age of internet of things, with the development and application of sensor technology, the virtual reality technology may break this barrier and enter the remote control field.

2. Internet of Things and Wireless Sensor Network

2.1. Internet of Things

Internet of Things, short as LOT, is firstly raised in 1999 by the Auto-ID Center in MIT (Sundmaeker *et al.*, 2010) [6]. In Nov. 2005, International Telecommunication Union, short as ITU, published a report called ITU the Report of Internet 2005: the Internet of Things in which the definition of the Internet of Things was confirmed [7].

The report pointed out that the development of the internet of things relies in RFID, WSN, IET, MT and NT. The internet of things, a network of intelligent identification, location, track, monitor and management, realises the exchange of information between people and things as well as things and things through connecting different kinds of things with internet.

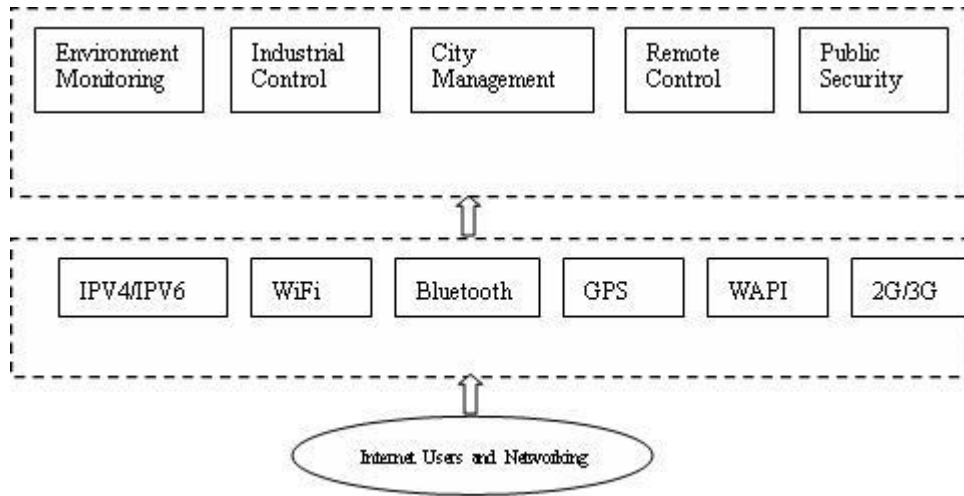The hierarchical structure of the internet of things as picture 1.1.

Figure 1.1. The Hierarchical Structure of the Internet of Things

2.2. Wireless Sensor Network

Sensor network technology is one of the most important technology in the internet of things. Wireless sensor network, an important part of the internet of things, connects the micro sensors in the monitor area to compose a vaulting network system with the purpose of cooperatively sensing, collecting and processing the information of the sensed object in the area to send them to the observers.

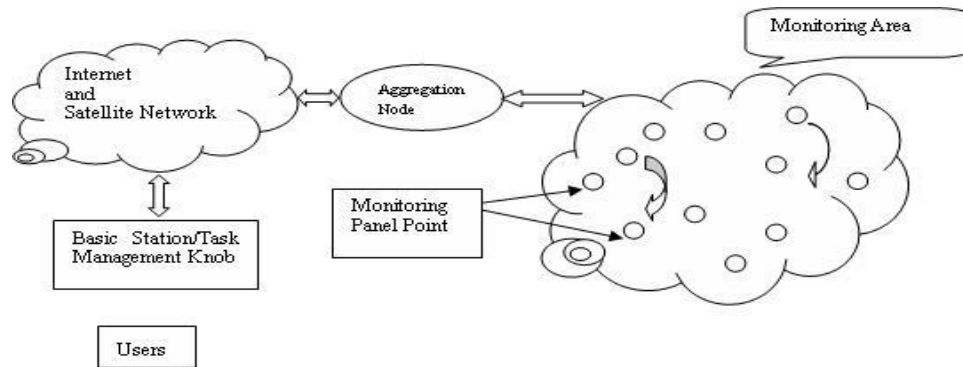Wireless sensor network's structure as picture 1.2.

Figure 1.2. Wireless Sensor Network's Structure

In the picture above, monitoring panel point is a micro embedded system which can process and deal with the local information and process the statistics, storage, management and fusion of the statistics from other points. The main task of panel points are to connect sensor network, internet and some other external networks to realise the information exchange among protocol stacks. Task manager or the basic station could be a computer or a working station that bears a big statistics processing or storage center and interactive platform of people and computer. Combined with the internet of things, sensor network is injected into

new energy and the application ability as well as the application scope, raising higher demands to other aspects.

3. Virtual Reality Technology and Remote Control

3.1. Brief of the Remote Control Technology

In the actual application, when it is difficult or impossible to realize the site control, or the cost is too high, the remote control can be used to replace the site control. Traditionally, the remote control largely means that the management staff can control the remote computer by local computer or network, such as remote assistance, remote education, remote maintenance, etc. Whereas in the industrial age, the remote control means that the operators operate on the remote computer, industrial equipments and industrial machines through internet by local computer and computer network, and control the whole production process through various operations[8]. And the immersion of virtual reality technology will make the remote control more real and precise, which will become the main orientation in the development of remote control technology in the future.

3.2 Application of the Virtual Reality Technology in the Remote Control Field

It can be known from the analysis above that the current remote control technology is single in operational mode, not flexible, and it is difficult to adjust at random according to the change of real situations; it can not make the operator "feel on the scene", that is, it can not provide the operator with the sense of immersion and interaction, so the effect is not very satisfactory. However, the virtual reality technology can compensate for the shortcomings above, and its immersion can further perfect the remote control technology.

3.2.1. Framework and Structure Drawing in Application

Under the environment of internet of things, the wide application of sensor technology makes it possible to apply the virtual reality technology in the remote control field. And the framework and structure in application is as showed in Figure 3.1.
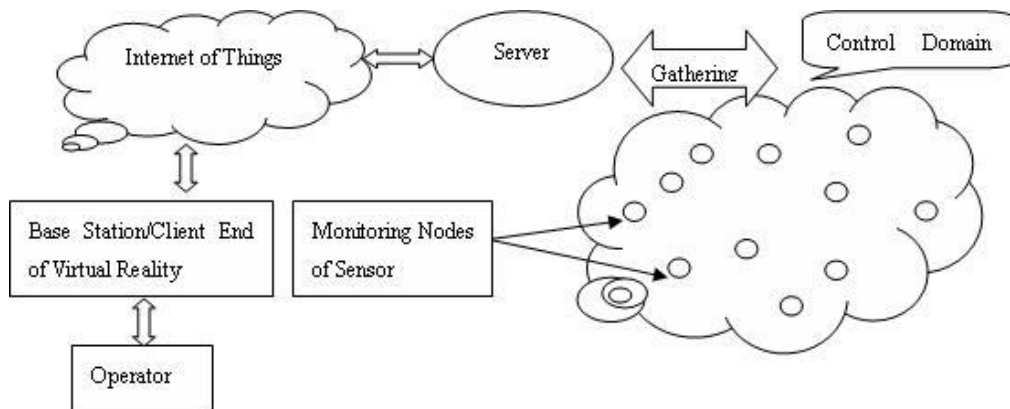

Figure 3.1. Framework and Structure Drawing in Application

In the drawing above, the signal collection and the command transfer in the remote control domain are realized by the nodes of sensor placed in the key positions within the domain. The functions of these nodes are very clear; they can be divided into two categories: one category

tests the indexes such as temperature, humidity, air pressure, and the other category is mainly in charge of the transfer of all control commands. The processing of all data and the realization of virtual reality are mainly accomplished by the remote server set in the control domain, and the site data collected by the sensor and the control commands sent by operator through the client end are perfectly combined with the virtual reality procedure by specially designed interface module [9].

3.2.2. Software and Hardware Platforms of the System

The software and hardware platforms required by the system are:

(1) Input and output equipments (such as helmet mounted display, stereo earphone, head tracking system and data gloves, *etc.*), data transfer network, etc.

(2) The virtual environment and its software, used to describe specific virtual environment, the dynamic features, structures and interaction rules, *etc*.

(3) The computer system and the outer equipments such as graphics and sound synthesis device [10].

The user puts on the helmet mounted display or data gloves under the enclosed BOOM or CAVE environment, obtains the sense of being on the scene by interacting with the virtual world, finally reaches the ideal state of "immersion, transcendence and nature", realizing the true control over the remote terminal [11].

3.2.3. User's Operation Procedure

As the performer of remote control, the user can "truly" observe the actual situations of the controlled domain by virtual reality technology. The change of the controlled domain can be digitally dealt with by the special server after the data collection of sensor and transferred to the far–end client by the internet. At the client end, when the operator needs operate on the remote control terminal, the operation can be conducted directly according to the demand under a virtual "reality" environment, and the content of operation can be transferred to the far-end server through the internet in the form of data, then after the compiling of server, the execution of final command will be completed by sensor. After the procedure above is completed, the sensor will continue to collect the current data and start repeating the previous procedure [12]. The specific operation procedure is as showed in Figure 3.2.
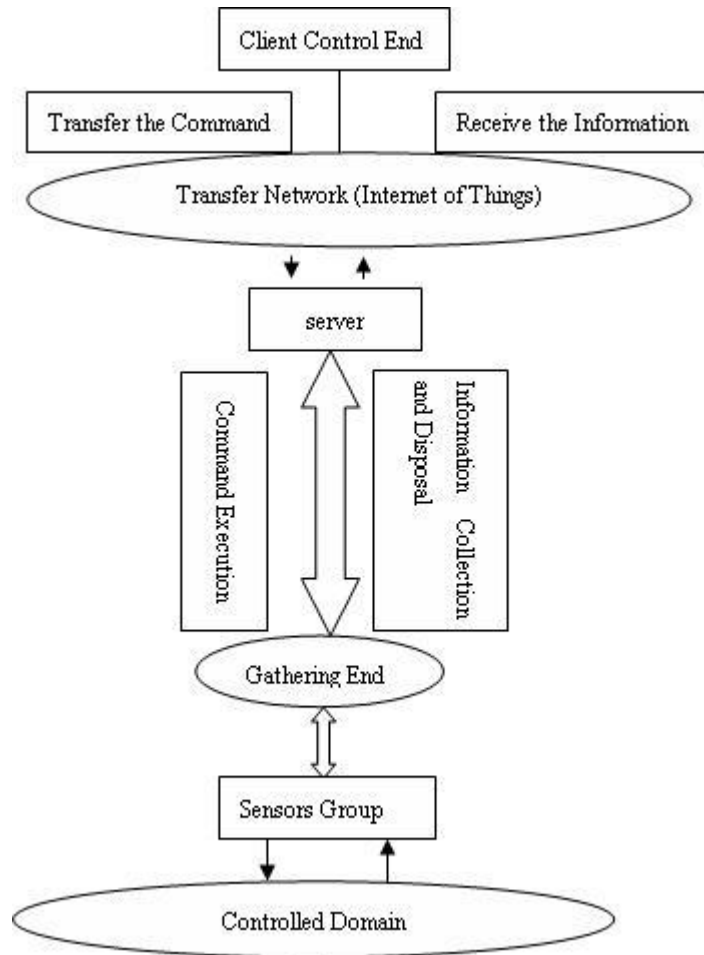
Figure 3.2. Flow Chart of the Operation of the System

4. Conclusion

Under the environment of internet of things, the wide application of sensor technology enables the virtual reality technology to possess the potential and space for further development in the remote control field. The functions of the sensor can mainly be divided into 2 aspects, one is to transfer the test data of all parts of the remote control domain to the operator instantly, the other is to execute the operator's remote control command within the control domain, meanwhile transfer the newest data of the site to the operator after the command is executed. The virtual reality technology makes the operator "truly" observe these data and execute the operational command, to realize the remote control over some special domains under the virtual reality environment.

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