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Mine Internet of Things based on Neural Network and its Research and Application

Zhen-yu Wang[1], Chun-lei Wang[1,2], Zhi-dong Wang[1], Shao-yi Jia[1]

[1]China Coal Research Institute, Beijing, China 100013

[2]School of Earth Science and Mapping Engineering, China University of Mining and Technology (Beijing), Beijing, China 100083

Design and Study on the Intelligent Management & Information Integration Based DC of Coal Enterprise

Keywords: Neural network; Internet of things; System engineering; Intelligent monitoring

Abstract. Internet of things is an ultimate development direction of the information age, while mine informatization is only way to realize the safety production and management of mining enterprise. In this paper, we research and simulate the human neural network system and propose the structure of internet of things based on human neural network. We connect all the objects and systems of the mines through mine internet of things to simulate the reflex activities of human body, regulate and control production, management and other links of the mining enterprises, so that it will become a coordinated and efficient whole.

I. Introduction

At present, it is evident that China's mine enterprises focus on investment and pay little attention to management; focus on local parts and pay attention to the whole; emphasize on hardware and pay little attention to software ,in order to change the current status and really realize the modernization on management of mine enterprises, this Article introduces the internet of things technology to the informatization construction of mine in accordance with the actual situation of mine enterprises, to study the operating mechanism of human neural network system mechanism, raise the structure of mine internet of things, and at last make it become an important means for mineral enterprise to achieve intensive production and low-carbon goal.

II. Human neural network system

Construction of the human Neural system in the structure of Mine Internet of Things, is a system model can learn from.

A. Composition of human neural network system

Neural system is composed of neurons and glia, and neurons are highly specialized cells and are the basic structure and functional units of the neural system, and it has the function to feel stimulus and transfer excitement. Neuron is composed of cell bodies and processes. The central cell body has nucleus, and there is cytoplasm around the nucleus, and the cytoplasm not only has mitochondria and endoplasmic reticulum that normal cells have, but also has special nerve fiber and Nissl body. Processes are divided into dendrites and axons. Dendrites are shorter but have more dendrite branches, which accept the impulse and will transfer the impulse to the cell body, and various types of neurons have different number of dendrites with different patterns. The axons are long and have less branches, and each neuron only sends a axons with different lengths, and the impulse generated by the cell body will be transmitted along the axon. Contact between neurons is to mutual interact and is not the mutual communication between the cytoplasm, and the structure of the contacted parts is called the synapse, usually there is functional connection of a neuron's axon and another neuron's dendrites or cell body synaptic, and nerve impulses is transmitted from one neuron to another through the synaptic. The number of neuronal glia is 10 to 50 times of the number of neurons, and the processes are not divided into dendrites and axons, and its cell body is smaller, and there is no nerve fiber and Nissl body in cytoplasm, and it does not have the function of the impulse conduction. Glia plays the role of

support, insulation, protection, nutrition on neurons and participates in constituting the blood-brain barrier.

According to the number of processes, the neurons can be divided into false unipolar neurons, bipolar neurons and multipolar neurons in morphology. Cell bodies of false unipolar neurons lie in the cerebral ganglion or spinal nerve nodes, and a process will be generated from the cell body, and will be divided into two branches in the near place, one is to connect the sensors in skin, movement system or internal organs, which is called peripheral processes, and the other branch enters the brain or spinal cord, which is called central processes. The bipolar neurons have more dendrites and an axon, and its cell bodies mainly lie in the brain and spinal cord, and partly exist in the visceral ganglion.

According to the function of neurons, the neurons can be divided into sensory neurons, movement neurons and connection neurons. Sensory neurons, also known as afferent neurons, usually located in the peripheral sensory ganglia, are the false unipolar or bipolar neurons, and peripheral processes of the sensory neurons may accept t a variety of stimuli from external environment, and the impulse will be transmitted to the nerve centre through cell bodies and central processes. Movement neurons, also known as efferent neurons, generally located in movement nuclei or surrounding nerve nodes of the brain and spinal cord, are the multipolar neurons, which will transmit the impulse from the nerve centre to the effectors such as muscles or glands. Connection neurons, also known as middle neurons, located between the sensory and movement neurons, play roles of the contact, and integration and other functions, are the multipolar neurons.

B. Operating mechanism of human neural network

The nervous system is divided into two parts: central nervous system and the peripheral nervous system. Central nervous system includes the brain and spinal cord, which are located in the central axis of the body. Brain is divided into the four parts: telencephalon, diencephalon, cerebellum and brain stem. The brain is also divided into left and right brain hemispheres for managing different parts of the body. Spinal cord is mainly the transmission pathway, which can transmit stimulus of the outside world to the brain in a timely manner, then send the orders issued by the brain to the surrounding organs in a timely manner, and plays a role as a bridge to connect the two parts. Peripheral nervous system includes the brain nerve, spinal nerves and autonomic nervous. Brain nerves are linked to brain and cross hole, crack, pipe at the bottom of the skull to other places from the cranial cavity, with a total of 12 pairs. Their names are Ⅰ olfactory nerve, Ⅱ optic nerve, Ⅲ oculomotor nerve, Ⅳ trochlear nerve, Ⅴ trigeminal nerve, Ⅵ abducens nerve, Ⅶ facial nerve, Ⅷ vestibulocochlear nerve, Ⅸ glossopharyngeal nerve, Ⅹ vagus nerve, Ⅺ accessory nerve and Ⅻ hypoglossal nerve, of which Ⅰ, Ⅱ, Ⅷ belong to afferent nerve, Ⅲ, Ⅳ, Ⅵ, Ⅺ, Ⅻ mainly belong to efferent nerves, Ⅴ, Ⅶ, Ⅸ, Ⅹ belong to mixed nerve. Brain nerves mainly dispose of feeling and movement of head and facial organs, so one can see things around, hear the sound, smell things, taste the flavor, as well as has the expression of emotions, because they have to rely on the functions of the 12 pairs of brain nerves. There are 31 pairs of spinal nerves, including 8 pairs of the cervical nerves, 12 pairs of thoracic nerves, 5 pairs of lumbar nerves, 5 pairs of sacral nerves, and 1 pair of the tail nerves. Spinal nerve is issued by the spinal cord, and mainly dominates the feeling, movement and reflection of the body and limbs. Autonomic nerves are also known as visceral nerves, mainly located in the viscera, cardiovascular and glands, and the heartbeat, respiratory and digestive activities are subject to its regulation. Autonomic nerve is divided into the two types of sympathetic nerves and parasympathetic nerves, which are restricted and coordinated by each other, to form an organic whole with tacit cooperation, so visceral activities can adapt to the needs of internal and external environments.

The brain functions in accordance with the principle of cross innervation. And left and right side of the brain have their own key division of labor respectively, such as the left brain responsible for language and logical thinking, right brain responsible for arts, thinking, etc. The activity functions of the nervous system are very complex, but the basic activity approach is reflex, which is the response made by the nervous system against the stimulus from the internal and external environments. Form

of reflex activity is based on reflex arc. The basic composition reflex arc is: receptor→afferent nerve →the nerve centre → efferent nerve→ effector. If obstacles occur to any link of the reflex arc, reflex activities will be reduced or lost, reflex arc must be complete, and each above parts are indispensable. After various information of internal and external environments are received by the receptor, the receptor will transmit such information through the peripheral nerve to the nerve centers at all levels of the brain and spinal cord for integration, and then the peripheral nerves will control and regulate the activities of all the systems and organs of the body in order to maintain relative balance between the body and internal and external environments. Spinal cord can complete some of the basic reflex activities.

C. Functions of human neural network

Human body is divided into nine systems: movement system, digestive system, respiratory system, circulatory system, urinary and reproductive system, Neural system, endocrine system, sensory system and the immune system according to the physiological function. Functions of human body's organs and systems are directly or directly under the regulation and control of the Neural system. The human body is a complex organism, and functions of various organs and systems are not isolated, and they are connected to each other and restrict each other. Neural system and various other organs and systems of the body have extremely broad and complex linkage. Neural system play a leading role in maintaining steady-state of internal environment, maintaining the intact unity of the body and harmonious balance with the external environment. By adjusting the body's functional activities, the neural system will make the body adapt to the changing external environment, maintain the balance of the body and the external environment; during the process of long-term evolution and development of human, neural system, particularly the cerebral cortex has a high degree of development, resulting in language and thinking, and the human will not merely passively adapt to changes in external environment, and can take the initiative to understand the objective world, transform the objective world, to make the nature serve human, which is one of the most important features of the human neural system.

III. Mine internet of things

Internet of things is to the network to connect anything with the Internet, to conduct information exchange and communication, in order to achieve intelligent identification, location, track, monitoring and management. Based on study on structure and operation mechanism of the human neural network system, according to the actual situation and actual demand of mining enterprises, this article will imitate the regulation and control functions of the neural system, and propose the structure of mine internet of things based on human body neural network.

A. Simulation of human neural network

All the elements of the entire mine shall be regards as a unified whole to give a life to mine, that is, the body of the mine. A mine has coal mining system, driving system, mechanical and electrical systems, transportation systems, ventilation systems and drainage systems and other systems. In addition, China will establish and improve six major underground safety and risk avoiding systems such as monitoring and control, personnel location, emergency avoidance, wind pressure self-rescue, water supply rescue and communication network.

All things of the mines are the objects to be connected by the mine internet of things, which are the basic structure and functional units of mine internet of things, such as underground boring machine, conveyor, a variety of sensors, switches and other equipment's and personnel and so on. Application of perception technology twill make the device the functions of "feel stimulation" and "transferring excitement", and above things are mine neurons. Perception technology is the technology used in the bottom of internet of things to perceive the information, including RFID and RFID reading technology, sensors and sensor networks, robotics intelligent sensing technology, remote sensing technology and the IC card and bar code technology, etc.

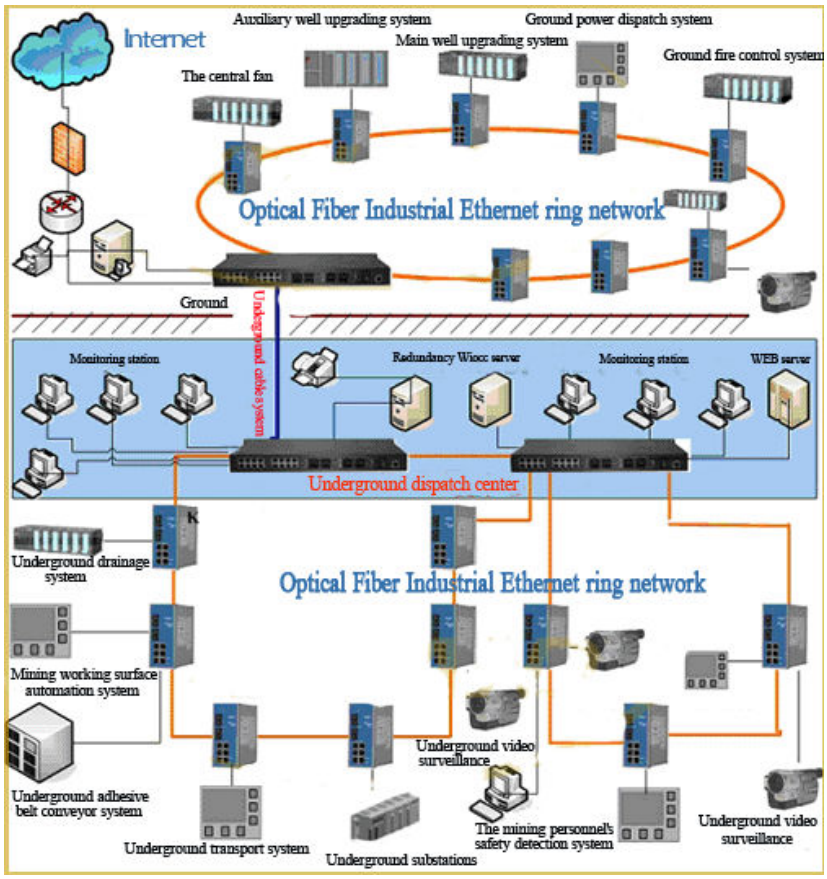

Figure 1. Network topology picture

Optical Fiber Industrial Ethernet ring network of the mine is the equivalent of the spinal cord to the mine, carrying most of the data communication (see Figure 1) of the mines. All objects of the mine shall be connected to conduct communication between each other in order to achieve the mine's intelligent identification, location, tracking, monitoring and management, which constitute the neural system of mines - mine internet of things. It divides various elements of the mine into four elements: man, machine, environment and management. Materials connection of the mine realized through this network, that is, to realize the connection between all the personnel of the mine, equipment and environment, will integrate various elements and systems of the mines into a complete unity. The purpose of connection is to realize communication, and the purpose of management is to conduct communications.

B. The feeling of mine - Monitoring and Control

The importance of mine safety management is not to be doubted. Mine internet of things is integrated of mine safety monitoring system and other systems, will certainly achieve better mine safety monitoring, to better meet the needs of "mine ventilation and gas control, mine dust control, mine fire control" management. Mine safety monitoring and control is "sense organ" of the neural system; underground mine video and audio acquisition device is equivalent to the eyes and ears of the mine to see and hear things that happen underground; sensor under the mine for determination of gas and other harmful gases or other air quality is equivalent to the nose of mine to sniff out the status of underground environment. Above feelings of mines are the stimulus of the mine to feel the external environment. To strengthen the management of mine equipment can effectively avoid the accidents caused due to the device management, and monitoring and control of the underground mine equipments is equivalent to the "autonomic nerve" of the mine to regulate and control the "heartbeat and breathing activities" of the mines, to ensure the normal efficient operation of the mine neural system.

Mine monitoring and control can be said as the simulation of the mine on the human body launch activities. The structure base of launching is emission arc, which includes non-conditioned reflex and the conditioned reflex, for example, when dust concentration of an underground

monitoring point exceeds the risk value, the coal dust concentration sensor receives this stimulus---the concentration of coal dust; and transmit such stimulus to the machine control station, and we will judge whether the concentration of coal dust exceeds a set threshold after the concentration of coal dust is received, when exceeding the set threshold, the control machine station will send the instruction to spray water, and the spraying equipment at this place will receive water spraying instructions and spray water to reduce dust, this is a simple coal mine reflex arc mine, and is also a “non-conditioned reflex mine”. Unconditioned reflex is congenital reaction that is inevitably to occur when the body meets a certain stimulus. The conditioned reflex is the acquired reflex gradually formed based on the non-conditioned reflex when the animal adapts to the changes in the environment in the living process, which is stimulated by the signal stimulus, and formed with participation of cerebral cortex. “Mine conditioned reflex” is the orders and decisions issued by the mine operations control center.

C. Structure of mine internet of things

In this article, the mine internet of things is divided into perception layer, analysis layer, transport layer, processing layer and application layer, and for the five layers of the system structure, see Figure 2.

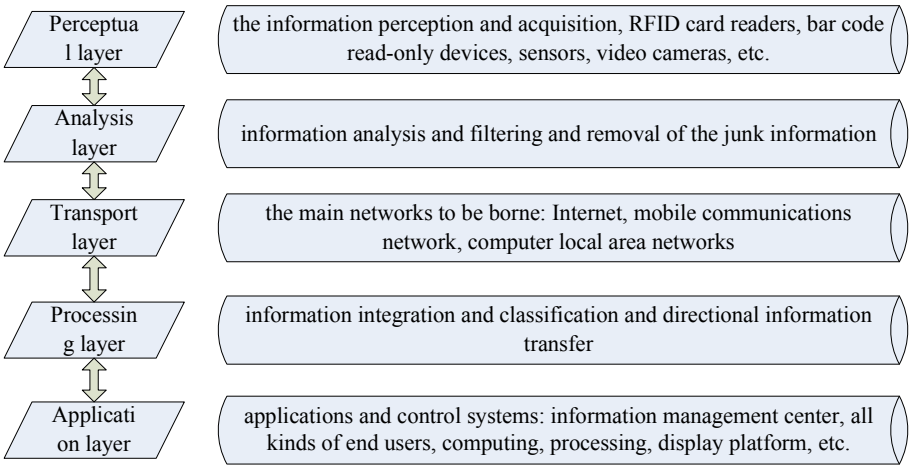

Figure 2. Structural diagram of Internet of Things

(1)Perceptual layer: the main functions of the perceived layer are to conduct information perception and collection, mainly including two-dimensional code labels, card readers, RFID tags and readers, cameras, sensors, video cameras. Such as temperature sensors, sound sensors, vibration sensors, pressure sensors, RFID card readers, two-dimensional code readers and so on, to complete data acquisition and device control over the application of mine internet of things to “receptor” and “effector” functions of neural network.

(2) Analytical layer: As the perceived layer conducts data acquisition in real time, and will directly transmit so much data to the upper layer, which is bound to increase data processing load and loss and damage to information package and reduce transmission speeds. This layer is mainly to conduct repair and selection of all data information collected by the underground sensing layer, to transmit the useful information to upper layer, and to cover and delete the repeated information.

(3)Transport Layer: Transport layer includes data access and network transmission. Data access completes network control of information of application terminal nodes and information collection and completes the information communication between the access layer and application layer of the Internet of things through the bearing network formed by various communication networks and the internet of things, such as 2G networks, 3G networks, 4G networks, the computer Internet, mobile communication network, enterprise network, etc. The main function of the transport layer is mainly borne by the sensor network (refer to self-government network composed of a large number of various types of sensor nodes).

(4) processing layer: the function of this layer is to store, collect, upload all the data transmitted, and this link will only transfer the information only useful for some system of the application layer, but

not send all the data packets to the application layer, make the systems on the application layer select the information useful to the system.

(5)Application layer: Application layer consists of various application servers (including the database server), relative to central neural system of the mine neural system. Its main functions include the convergence, transformation and analysis of data acquired, and acquisition of the information about the adaptation and user-level event triggers displayed by the user layer, for a lot of raw data are obtained from the peripheral node, and these raw data shall have practical value for the users only through conversion, screening, analysis and processing of such data; The application server with the contents of actual value will complete adaptation of different information displayed in accordance with the users' display device, and shall trigger relevant notice information in accordance with the user setting. And when it is necessary to complete the control over the peripheral nodes, the application layer can also complete the control instructions generation and control instructions issuance.

IV. Application and research of mine internet of things

Donghuai Mine of Baise Mining Bureau in Guangxi Province built a three-dimensional virtual mine intelligent management platform (see Figure 3) in 2009, which is a prototype of application and research of mine internet of things. Through the Gigabit Ethernet ring network and built industrial wireless WIFI network, systematic integration of underground roof pressure system, personnel positioning systems, gas monitoring system, underground wireless communication system and video surveillance system have been conducted.

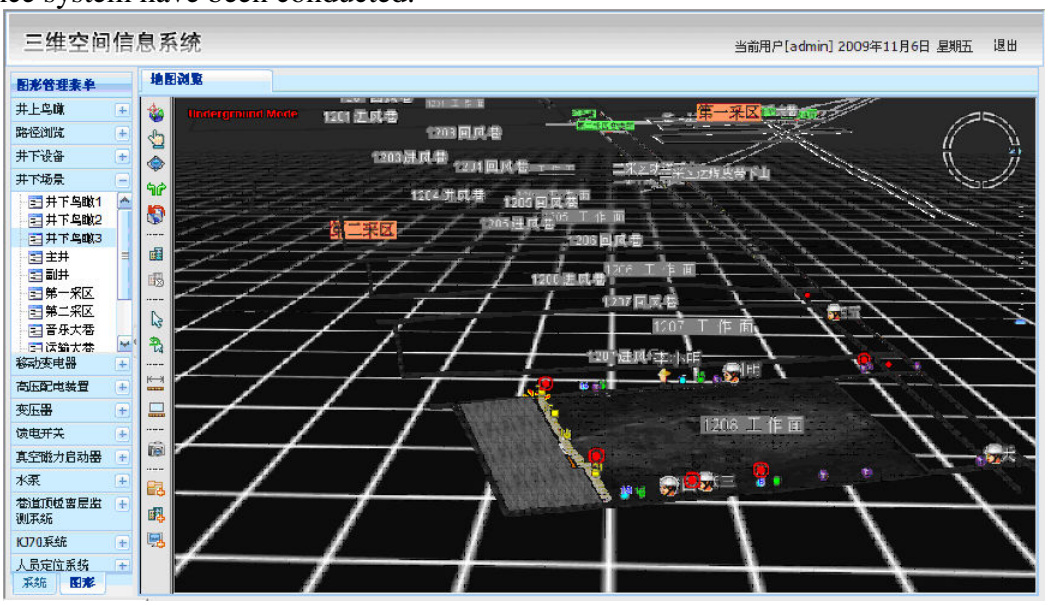

Figure 3. Three-dimensional Virtual Mine Intelligent Management Platform

Among them, the underground separation layer pressure sensors, bolt stress sensor, hydraulic support pressure sensors, gas monitoring sensors, personnel positioning RFID card readers and communications base stations, underground explosion-proof cameras belong to the perception layer devices referred to herein, and their functions are to complete the data acquisition and device control under the structure of coal mine internet of things; intelligent data mining tools and embedded device data acquisition software, integrated dedicated processing core and data filtering techniques belong to the analytical layer referred to herein and their function is to complete the information analysis and screening and elimination of information waste; Gigabit Industrial Ethernet ring network and the erected wireless WIFI network, Internet, mobile communication network and computer local area network belong to transport layer referred to herein, and their function is to complete the data transmission; Processing software of each subsystem belongs to the processing layer referred to herein, and their functions are to complete the information integration and classification and the

directional information transmission; three-dimensional virtual mine management platform is the application layer intelligent software mentioned in this article, and its function is to complete the information exchange between the subsystems, to achieve computing, processing and display of various types of end-users.

V. Conclusions

This article discusses and studies the human neural network system and researches and designs the structure of mine internet of things, and draws the following conclusions:
(1) The human neural system is a system model that we can learn from in the process to build the structure of mine internet of things. Mine internet of things based on neural network is the development direction of mine informatization.
(2) Mine internet of things systematically integrates various types of things elements into a unified whole, to make things interconnection achieve mutual communication of "man, machine, environment and management of the mine.
(3) The article proposes the theory about non-conditioned reflex and conditioned reflex simulating human, and enhances the management and technical level of "mine ventilation and gas control, mine dust control, mine fire control" management.
(4) The articles proposes the structure of mine internet of things based on neural network, and the internet of things has been verified by Donghuai Mine of Baise Mining Bureau in Guangxi Province to have good implementation and operation situation, and has improved the coal mine safety production management level

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