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Research on the Application of Smart Site Management for Cross-regional Power Grid Project Based on the Basic Framework of Digital Power Grid

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Abstract. In order to further improve the infrastructure management level of power grid projects and promote the fine management and scientific organization of power grid projects. Based on the basic framework of digital power grid, this paper uses UAV remote sensing, geographic information system, 3D virtual simulation, mobile Internet, Internet of things, intelligent sensor and other technical means to build a intelligent management and control platform integrating monitoring, early warning, command and emergency response. Exploring the application scenarios in terms of project schedule, quality, safety, special project, and on-site Internet of things perception. Practice shows that the construction of the platform can effectively improve the overall control of the power grid construction site and all kinds of information control level and risk prevention and control capabilities..

1. Introduction

The southwestern region has a vast territory, spanning five provinces and cities including Yunnan, Guizhou, Sichuan, Tibet and Chongqing. The area covers a variety of landforms. Within the jurisdiction of the Hengduan Mountains and valleys, the surface is undulating, sparsely populated, the original forest is dense, and the traffic conditions are poor, which causes the power grid project to face many difficulties and challenges in the construction management. It is mainly reflected in the problems of high construction safety risk, difficulty in man-machine management, strict construction and construction standards, high emergency response requirements, and insufficient data sharing between different business platforms. It has seriously affected the construction management units at all levels to master the management information of the construction process of the project site in a comprehensive, timely and dynamic way, and to strengthen the coordination of the site construction and the management of safety, quality and progress[1-2].

At present, building a strong smart grid has become the main means to meet the future construction and management of power grid projects. As an important foundation for building a smart grid, the digital grid provides unified external data services and functional applications by integrating multi-source data such as basic geography, geomorphology, power grid topics, and power grid projects, and



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its development has also received more and more attention from the industry [3]. The digital grid covers a variety of real grid resources, grid space geographic information, planning, design, construction, three-dimensional digital results of various resources during operation and intelligent scheduling of the grid, real-time synchronous data collection and many other content [4]. Through the full information three-dimensional visual simulation of the power grid, the geographical distribution, operation mode, power grid current and other information of the power system can be clearly grasped, and the route, topography, mountains and rivers, railway roads, towns and villages, as well as various power grid thematic data and other contents can be visually inspected.

The smart site is a technical means of intelligent management of construction site by means of informatization, Internet of things and other technical means in recent years. By establishing an engineering project information model and using Internet of things intelligent hardware to collect engineering-related data in real time, an information ecosystem based on construction process management is created to realize an efficient management mode of collaborative interconnection, intelligent monitoring, and scientific decision-making. And the engineering information model and the engineering environment data collected by the Internet of Things are used for mining analysis to provide process trend prediction and scientific plan for the project construction, to realize visual management and intelligent decision-making of the project construction, thereby gradually realizing green construction and intelligent construction. At present, the application of "smart site" in "point" or "block" (such as the field of housing construction) projects is increasingly mature [5,6]. Compared with the traditional construction industry, the "smart" of engineering management in the power industry is still in its infancy. In addition to some pilot applications in the fields of power transmission and transformation equipment inspection, intelligent customer service response, robot voice interaction, intelligent voice quality inspection, etc., it is rarely used in the management of power grid infrastructure projects, which is far from the development requirements of digitalization, networking and intelligence [7].

Based on the basic framework of digital grid, this paper constructs the smart site system of power grid engineering. The system focuses on the construction site, closely surrounding the key factors of grid engineering infrastructure construction, safety, quality, materials, design, etc., and comprehensively uses new technologies such as Internet of Things, mobile applications, big data, cloud computing, and integration with the construction process. It integrates with the construction production process to establish an on-site management ecosystem of intelligent infrastructure, interconnected collaboration and scientific management of the power grid infrastructure project to realize visual, fine and intelligent management of the power grid site, and effectively improve the project site management level.

2. Construction Idea of Smart Site System Based on the Basic Framework of Digital Power Grid

2.1. Construction idea

Based on the basic framework of digital power grid, with engineering progress, quality, safety and supervision as the core of the business, the three-dimensional digital site of the line and convert station is constructed through the geographic data and three-dimensional model data of the construction site. Through the implementation of the application project management business app platform, intelligent sensing material equipment, and environmental protection monitoring system, based on the ubiquitous power Internet of Things concept, multi-channel intelligent sensing is realized, and the intelligent level of the sensing layer is improved. Relying on the multi-system network system, highlighting the flexible deployment capability of the network layer; basing on the problem-oriented governance guidance, increasing the intelligent monitoring capability of the application layer, and creating the intelligent "brain" of engineering construction management. The effective connection of the information layer, the field layer, the supervision layer and the command layer is constructed to realize the automation, accurate and efficient transmission of information, reduce the workload of project management, and improve the efficiency of project management. The overall idea is shown below.

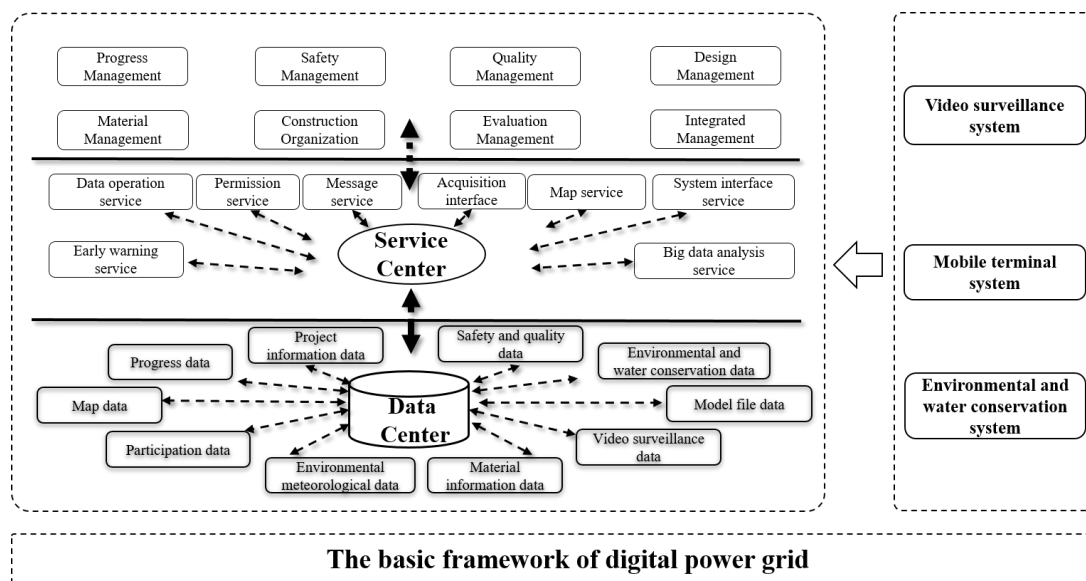


Figure 1. The overall architecture of the smart site system based on the basic framework of digital power grid

2.2. Design of overall architecture

Relying on the basic framework of digital power grid and the visualization results of digital power grid, in order to build a more reasonable business system of smart site, the system adopts advanced information technology to transmit the data collected by terminal equipment to the platform through the network, thereby realizing the intelligent and Internet management of personnel, environment, safety, quality and other business links. The construction of sensing layer covers field intelligent sensor hardware, UAV, etc. The construction of network layer covers all kinds of sensor hardware data access and support network. The platform layer involves the construction platform of smart site, and the application layer involves personnel, safety, quality, progress and other business applications.

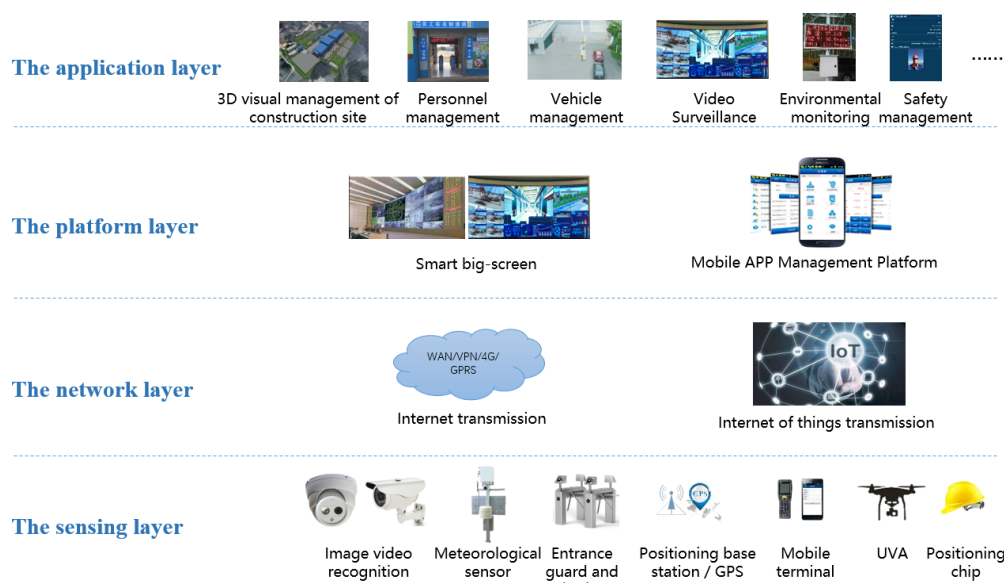


Figure 2. The overall architecture

The main function of the sensing layer is to collect all kinds of data on the construction site. Through Internet of Things technology and terminal equipment such as sensors, cameras, mobile phones, positioning tags, access control and attendance equipment, it realizes the dynamic monitoring, intelligent perception, data collection and efficient collaboration of field personnel, equipment, environment, material management, etc., and improves the field management ability.

As the link between the sensing layer and the platform layer, the network layer is responsible for transmitting the information acquired by the sensing layer to the platform layer securely and reliably. It constructs the network transmission system through the Internet, mobile communication network, satellite communication and other infrastructure, ensuring the field data transmission without obstacles, high reliability and high security.

The platform layer mainly includes large screen system and mobile app system. The large screen system intuitively displays the digital scene of the construction site, connects personnel attendance and vehicle management system, online accesses to personnel, equipment, materials, video, environment and micro meteorology and other remote sensing information. It realizes dynamic monitoring, analysis, early warning and visual management of the approach personnel, vehicle equipment, working environment, video monitoring, material pre-storage, material transportation, construction progress, human and machine safety, quality management and environmental protection and water conservation. The mobile APP system realizes real-time reporting and sharing of various information such as personnel, security, and construction progress through the mobile Internet.

The application layer realizes construction management, on-site monitoring command and emergency dispatching in the form of three-dimensional digital site modeling, multi-style chart and video screen display through large screen, mobile app and other display application terminals, and provides strong support for project construction consultation and image publicity.

3. Application of Engineering Smart Site Management Based on the Digital Power Grid

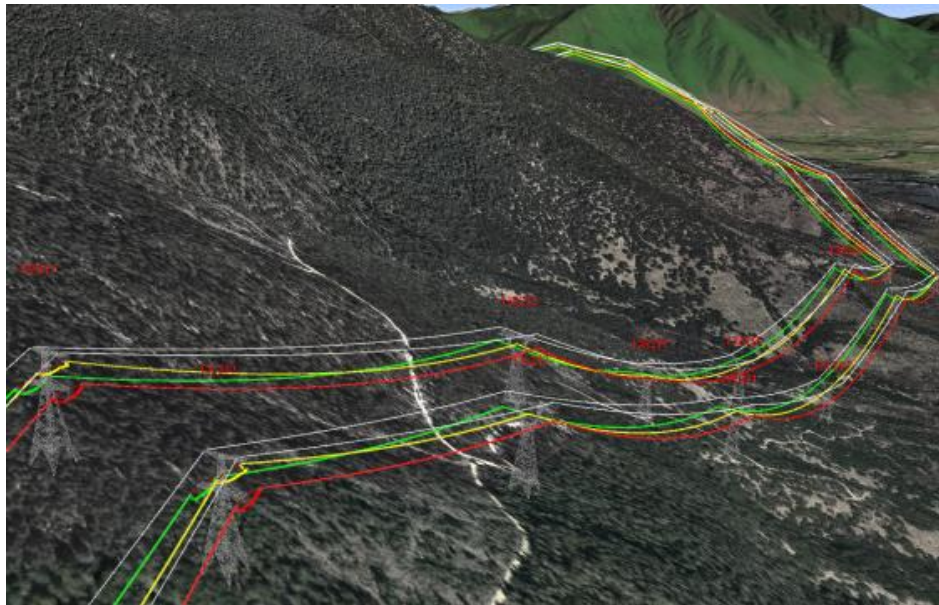
In this paper, the system is applied to cross-regional power grid projects. Based on the digital power grid, a visible management system is built to carry out the on-site progress, safety risk, quality, materials, environmental protection and water conservation of power grid projects. The practice shows that it can effectively improve the whole process, visualization and lean management of power grid project.

3.1. 3D digital site

Using the digital achievements, combining with 3D GIS, 3D modeling and other technologies, integrate 3D digital terrain, 3D building model, risk source model, 3D site model, key construction equipment model and other ground 3D models around the project site. To construct the three-dimensional digital landform of the engineering ground and the three-dimensional visual scene of each construction site. Combining the three-dimensional visual macro display of the project with the micro fine expression of civil engineering and electrical construction, it visually displays the connection relationship between the whole scene outside the station and the layout of the construction site.



a) The visual site scene of substation



b) The visual site scene of line

Figure 3. The 3D digital site

3.2. Visual monitoring of multi-level progress

Combine the construction progress of the project in real time, and use the key process as the progress unit to construct a multi-level progress visual monitoring system for the whole project, each bid section and each foundation tower. Display the real-time progress proportion of the project in the form of pie chart, bar chart, etc., and realize the visual monitoring of the progress indicators. Strengthen the comparison and analysis of the plan and progress, assist the project department to carry out the three-dimensional intuitive control of the overall progress of the project, and realize the closed-loop management.

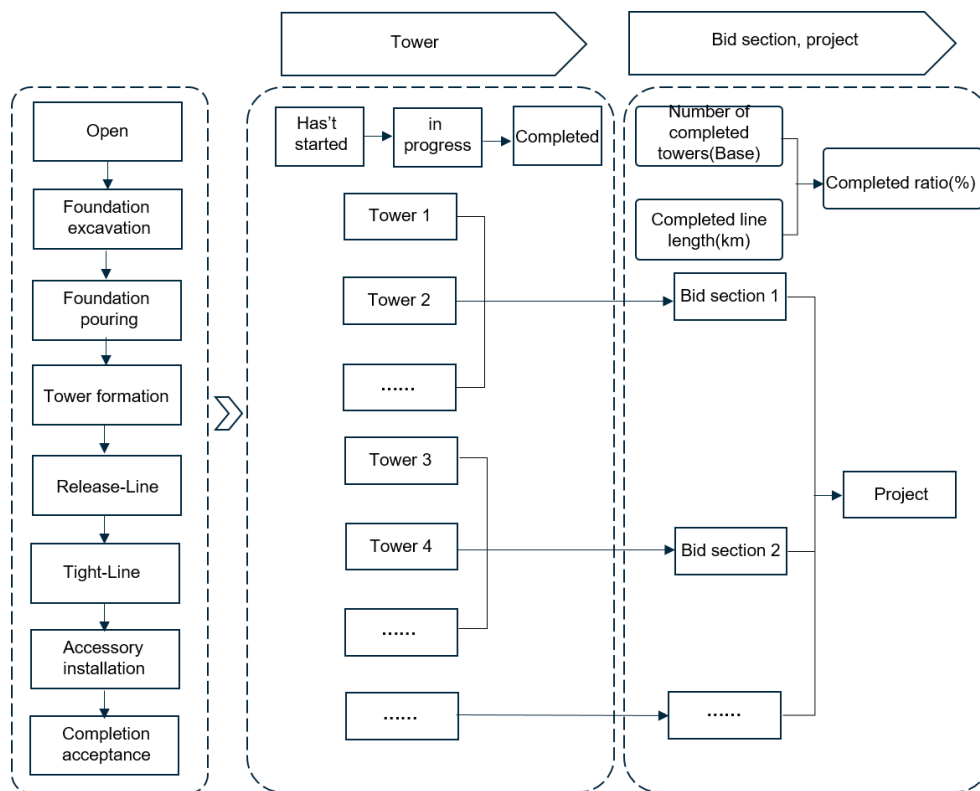


Figure 4. The management of multi-level progress



Figure 5. The visual monitoring of progress

Using the digital grid achievements, combined with the three-dimensional digital site and the construction state model of the main construction process, the three-dimensional visual simulation of the main process of the project is carried out. At the same time, combining with the historical progress data, the construction process and construction state can be traced back to realize the dynamic visual simulation of the installation of main construction equipment and key construction process.

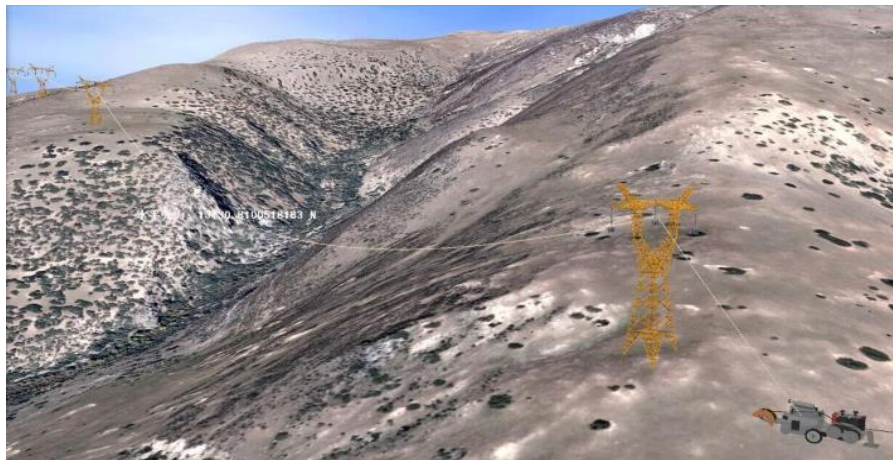
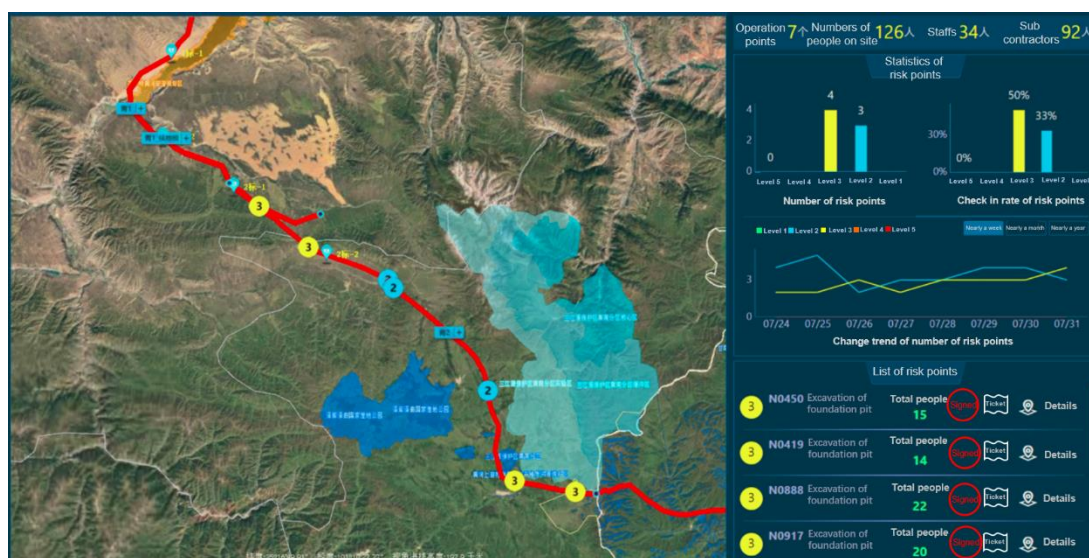


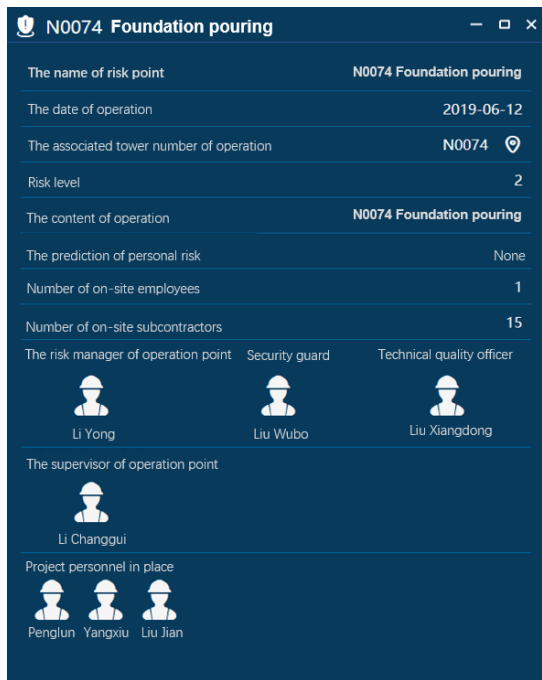
Figure 6. The simulation of construction schedule

3.3. Pre-control of operation safety and risk

Based on mobile app and positioning technology, a operation daily pre-control management mechanism for the construction site is constructed. Manage the risk operation points in the project, realize the daily, weekly and monthly pre-control report and approval management, construction site personnel sign-on management, risk statistics analysis, etc, and quickly locate and navigate the risk operation location information on the map. Through the reporting and layer-by-layer approval of the intelligent terminal daily pre-control, implement the safety responsibilities of all levels of participating units, combine with the attendance record of risk points operation, and supervise the safety patrol of personnel on duty.



a) Distribution of risk operation points and statistics of key personnel on duty



N0074 Foundation pouring

The name of risk point: N0074 Foundation pouring

The date of operation: 2019-06-12

The associated tower number of operation: N0074

Risk level: 2

The content of operation: N0074 Foundation pouring

The prediction of personal risk: None

Number of on-site employees: 1

Number of on-site subcontractors: 15

The risk manager of operation point: Security guard: Li Yong, Technical quality officer: Liu Wubo

The supervisor of operation point: Li Changgui

Project personnel in place: Penglun, Yangxiu, Liu Jian



N0452 Foundation pouring

Name: Rao Qing

Telephone: 13997238488

Department: Construction Project Department

Check-in time: 6/12/2019 8:26 上午

Tower: N0452

Distance: 229

Address: Zeku County, Huangnan Tibetan Autonomous Prefecture, Qinghai Province

Whether the content of the field work is consistent with the report: ☒



b) Key personnel on duty and location check-in

Figure 7. Safety risk management and control of operation point

3.4. Inspection and bulletin of construction site

Establish a sound classification system for safety and quality inspection at all levels of the construction site. The site completes the electronic filling and circulation of various inspection forms based on the mobile terminal, obtains the existing problems and highlights of the construction site, issues the safety and quality inspection results, establishes a closed-loop mechanism for the problems of the safety and quality inspection results, and makes the management personnel clear about the safety and quality inspection of the project within their jurisdiction.

The issue of problems		The issue of rectifications		The issue of reviews	
Problem classifications	Safe and civilized construction	Settling time	2019-07-10 22:59:17	The issue of reviews	Review passed
Severity level	General problem	The rectification manager	Li Yong	Review time	2019-07-10 23:13:54
Deadline of rectification	2019-07-09	Rectification results	Rectified	Review person	Liu Shunhua
Problem description	Material stacking is unpaved and clearly marked	The annex of rectification			
The unit of rectification	The department of construction project				
Problem formulation	No signs placed in the raw soil area				
The annex of problem					

Figure 8. The management of inspection and bulletin

3.5. Special verification of environmental protection and water conservation

Based on mobile internet + Big Dipper + autonomous UAV remote sensing, an integrated monitoring system for environmental protection of air and water is constructed. Based on the requirements of environmental and water conservation measures of "one tower one map" in the design stage, the implementation of all the towers in the whole line shall be verified one by one. Based on the original landform situation in the design stage, the remote sensing image is interpreted three-dimensional to reflect the environmental and water conservation situation on site through construction unit UAV self-inspection, on-site app acquisition and third-party monitoring unit UAV patrol and other three channels during the construction and completion stage. According to this and combining with the design requirements, check the implementation of the environmental and water conservation of the step-by-step tower, and clarify the implemented and not implemented environmental and water conservation measures. Thus, the whole process of environmental assessment and water conservation supervision can be realized before, during and after the event.

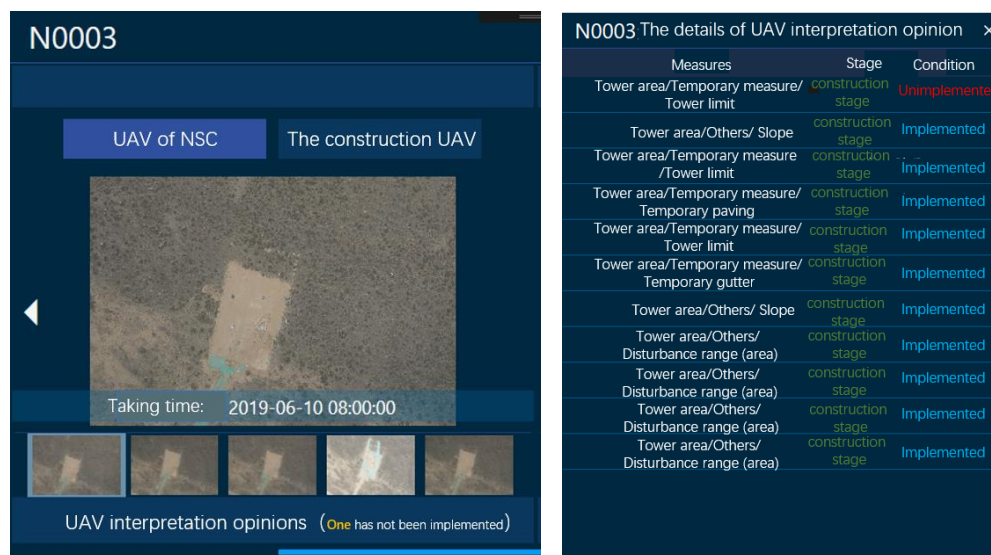


Figure 9. The environmental protection and water conservation image of the project and the UAV interpretation information

3.6. Real-time IOT perception on site

Use mobile phones, 4G ball machines, mobile soldiers, sensor equipment, UAVs and other devices to carry out mobile intelligent video monitoring in the whole area, realize the ubiquitous aggregation of 'people, machines, things, methods, rings', and realize the interconnection of things, people and things. For example, the distribution of each surveillance camera can be visualized by 3D digital site, and the camera model can be used as an entrance to realize the real-time access of multi manufacturers and multi types of video surveillance signals, which can quickly access and read the real-time video of the designated monitoring point and control the cloud platform. Through video monitoring, the management personnel could strengthen the timely control of the site conditions, and create the 'Clairvoyance' of the project.



Figure 10. Remote video perception

4. Conclusion

Based on the basic framework of digital power grid, this paper constructs the smart site system of cross-regional power grid project. The system integrates project progress, safety, quality, materials, archives, environmental and water conservation management, and adopts mobile app, on-site video monitoring, UAV environmental and water conservation verification and other omnibearing three-dimensional means. By dynamically summarizing the data of all links in the whole process of construction site to assist the construction units at all levels to comprehensively, intuitively and timely grasp the dynamics of the project site infrastructure, and provide information support and decision-making basis for the whole process of project infrastructure construction. With the in-depth construction of the power Internet of things of State Grid Corporation of China, aiming at the practical application of the project, it is necessary to dig deep into the potential of project management and control, improve the monitoring system, and gradually realize the functions of internal integration, external sharing, up-down connection, data sharing, analysis and judgment, and intelligent management and control, so as to lay the foundation for accurate dynamic analysis, intelligent comprehensive prediction and comprehensive and accurate monitoring of the project. Truly build a smart "one network" of the entire business chain of the infrastructure management system, and fully optimize the infrastructure management ecosystem..

References

- [1] LI Zheng, XU Qianjiang, ZHANG Feng, WANG Bing. Application of Smart Site System in Construction Process [J]. Building Electricity, 2017 (9): 63-66.
- [2] CONG Haihu, WANG Xuliang, WU Hong. Practical Research on Building the Four-Dimensional Integrated Smart Site Based on BIM Technology [J]. Intelligent Building & Smart City, 2018, 264 (11): 65-66.
- [3] STATE GRID. Research Framework of Key Technologies of Digital Power Grid [Z], 2007.7.
- [4] JIANG Rongan, YAN Ping. Application of 3D Digital the Electricity Network Technique in the Construction Management of Extra High Voltage Engineering [J]. Electric Power Survey & Design, 2007 (5): 65-68.
- [5] ZENG Ningshuang, LIU Yan, XU Bo. On-site Construction Management Framework Based on Building Information Modeling System [J]. Construction Technology, 2015, 44 (10): 96-100.
- [6] MAO Zhibing. Promoting the Construction of Intelligent Sites to Advance Sustainable and

Healthy Development of Construction Industry. Journal of Engineering Management, 2017 (5): 80-84.

- [7] ZOU Jieping. On the Application of ‘Smart Construction Site’ in Power Grid Engineering. Science and Technology & Innovation, 2019 (16): 158-159.