Design for perception management system on offshore reef based on integrated management

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Abstract. According to an analysis of actual monitoring demands using integrated management and information technology, a quad monitoring system is proposed to provide intelligent perception of offshore reefs, including indoor building environments, architectural structures, and facilities and perimeter integrity. This will strengthen the ability to analyse and evaluate offshore reef operation and health, promoting efficiency in decision making.

1 Introduction
In recent years, countries around the world have been focusing on Marine economy, and the concept of sea power has risen to a national strategic priority. As marine reefs become the focus of strategic activities and even some disputes, countries have intensively developed reef infrastructure. There are several items that need to be considered in this process: First, geographic characteristics, including distance from the sea, high temperature, high humidity and the high salt environment, and a lack of design experience with specific construction technologies and special materials, which can endanger the health of the buildings or structures. Second, whether the indoor environment meets necessary standards and conforms to living and working requirements. Third, the relationship between the environment and building, specifically the interaction of the unique environment and border security problems expected during future operations. Although monitoring technology is relatively mature, the integration of a reef monitoring system and information has not been adequately explored. An integrated management idea for offshore reef engineering, combined with the indoor environment, building entity, facilities environment, and border security will be discussed in this paper.

2 Role of integration management in reef monitoring
Integrated management philosophies inspired a system coordination idea [1] which was put forward by American scholar Chester Barnard. The economist Joseph Schumpeter subsequently proposed the integration of technology and management [2] through technological innovation. While integrated management theory was first presented by Qian Xuesen in our country. According to the research, the overall integration of construction project management could be divided into elements integration, information integration, technology integration, method integration, process integration, and participant integration. In the process of operational management, especially for reef monitoring, integration management, which combines the elements of management ideas, information, and technology, plays a more important role, as shown in Figure 1.
In this method, the offshore reef is monitored from the inside out, from macro to micro, from a local to a global view instead of just using video technology to monitor the reef appearance. By monitoring a broad range of data for an offshore reef, a system model baseline is established which includes the indoor environment of buildings or structures, the construction entity, the facility environment, and the reef perimeter monitoring elements. While different monitoring technologies are used to monitor different objects and get index parameters, observation data, and a standard index, the analysis results and other information are integrated together. As a result, information from the perceptual system can be shared and collaboratively managed.

3 Base information platform for offshore reefs
A wide variety of information for an offshore reef is needed for a comprehensive understanding of the reef monitoring objects. Additionally, precise offshore reef basic geospatial information is very important to island ocean management, economic development and coastal defences security \[3\]. Therefore, we obtain offshore reef information in many areas, such as topographic data, digital elevation models, digital orthogonal projections and cartographic data by aircraft and satellite image data, to build reef mapping in high accuracy (e.g., geodetic datum, vertical datum and gravity datum). Additionally, based on the offshore reef building information model, it assists with the design of architectural structures. When the construction is finished, it establishes an entire reef data platform including engineering science, by combining the complete information fusion model with the geographic information, macro geographic information data, and micro infrastructure data by using digital earth 3D visualization technology, as shown in Figure 2.

4 Overall framework of offshore reef wisdom perception system
According to the problems encountered during the construction of a reef, a concept, namely, offshore reef wisdom construction management, is put forward here, which integrates engineering system theory and the theory of Lean. This management concept can facilitate the coupling of integrated management and information technology, optimize the relationship between resources and organization, hardware and software, test and prototype, technology and management, information and ideas, and improve the science, rationality and accuracy of the engineering design, construction and operation. Additionally, it can assist with construction organization coordination, information integration, sensing, organizational behaviour, and management wisdom on the reef. As an important part of intelligent construction management, an offshore reef engineering perception system implants the concept of lessons learned in four key areas: the indoor environment, the construction entity, the facility environment, and perimeter security. This is done based on geographic and building information and is made from the system perception platform by integrating various kinds of sensing components, application software and hardware equipment, as shown in Figure 3.

The whole process allows managers to monitor offshore reef health and to make decisions in a timely manner through the real-time online interface that facilitates human-machine interactions.

5 Quad perception system analyses

5.1 Indoor environmental monitoring principles
As the first heavy reef perception system, indoor environment monitoring principles can be divided into information collection, information processing and information sharing. Information collection: first determine the object of monitoring parameters through the front sensing component for indoor air quality, temperature, humidity, illumination, and noise environment indices data; Information processing: combine the data collected through the microprocessor, in the human-computer interaction environment, with a standard index, and connect to the network transmission module; Information sharing: compare and analyse the indoor environmental parameters and transmit the analysis results to a remote terminal through the network to help the manager dispose the indoor environment of information in the distal, as shown in Figure 4.
5.2 Relationships between construction entities and environmental monitoring facilities

According to the service characteristics and special requirements of reef constructions, fibre sensing technology is used which contains a multi-parameter online distributed optical fibre sensing test method, an optical signal transmission method with low attenuation over long distances, and signal measurement processing. Additionally, state recognition and analysis, evaluation, early warning and forecasting methods are used to analyse the status of the infrastructure (including temperature, pressure, displacement/vibration, stress/strain, landslides, etc.). This helps reef managers make decisions by providing long-term health monitoring for major buildings, structures (including underground structures), deformation, durability, and any oil structure or gas pipeline corrosion or leakage.

Because of the different monitoring parameters, technical methods, and professional requirements, the environment and buildings usually require two independent monitoring systems. However, when the construction entity monitoring alarm, the building itself has had more or less of the displacement, stress and strain, and even damage, besides offshore reef’s special geographical position and climate environment, infrastructure environment adaptability are different from the mainland, so it is necessary to count the monitoring information data of building entities and facilities of environment by using data mining technology and exploring the mathematical relationship to finally predict the status of the construction entity which makes warning function carry on, as shown in Figure 5.
5.3 Perimeter security awareness

Offshore reef perimeter security online monitoring systems have been established for a long time with the fourth perception system mentioned above. Many methods that are used in underwater reef engineering are combined, including distributed optical fibre sensing online test methods, automatic identification of perimeter invasion, long distance safety detection optical signal transmission method, distribution analysis of testing signals, state recognition, and intelligent characteristics evaluation.

Moreover, grating the optical fibre sensor probe has many advantages, including corrosion resistance, electromagnetic interference protection, improved signal transmission distance, multipoint distribution monitoring and simple networking capabilities. Thus, offshore reef safety monitoring requirements can be met by arraying the optical fibre grating sensor on the prefabricated stainless steel stent, which can then differentiate between the vibration response of the optical fibre sensor and wave pattern noise. It will be used to monitor reef perimeter security by sounding an alarm in response to vibration, as shown in Figure 6.

Figure 5. Environmental and building monitoring

6 conclusions

It has been found that real-time observation of infrastructure and the status of the whole reef will become the focus of operations management. With the assistance of an integrated management intelligent perception system, this status will be accurately monitored, analysed, and shared across
facilities, environmental systems and boundary information quickly. This can provide via network the information necessary for management to make decisions remotely.

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