

## Dynamic analysis on the novel concept of underwater tracked vehicle and long flexible riser in deep-seabed mining system

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### Abstract

Manganese nodules containing nickel, cobalt and copper are representative deepsea mineral resource and are spread in water depth of 3000 ~ 5000m. Especially, they are situated at CCFZ (Clarion-Clipperton Fracture Zone) in the Pacific. To date many concepts of the commercial production for deepsea manganese nodules have been studied from the 1970s [1~4].

The environments of deepsea are harsh conditions such as the high pressure and low temperature. Also, the bearing capacity of deep-seabed is not good working condition for the mining facilities because the accumulate ground is formed by fine particles with high moisture content. To tackle this problem, the continuous mining system such as figure 1 is used for mining deepsea mineral. This system is composed of a mining vessel, a lifting system, a flexible pipe, a buffer and a mining robot.

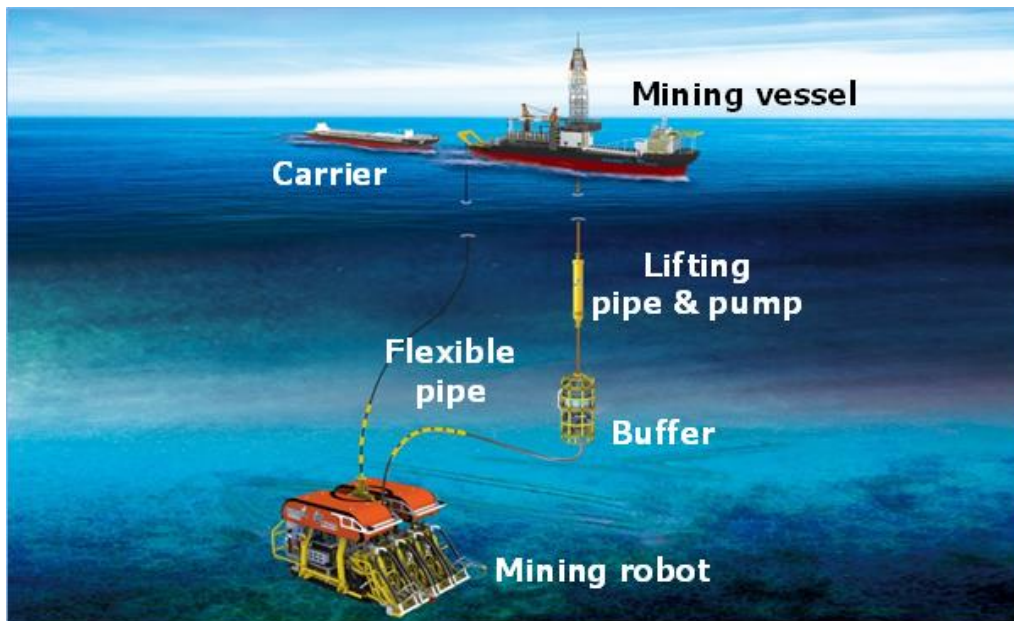


Figure 1: Conceptual diagram of deep-seabed mining system.

The mining robot and the buffer are connected by the flexible pipe for stable transfer of the minerals. However, motion of the flexible pipe must not influence on motion of the mining robot. So, many buoyancy modules should be equipped at the flexible pipe to make S-shape, which can be resolved the problem. Installation of the buoyancy module is very difficult due to ocean environment such as wave, current and so on. Although the modules are installed at the flexible pipe, the pipe has a large motion due to flexible characteristic. The mining robot has no choice but to be a large affected by this influence. Motions of the flexible pipe and the mining robot are disconnected to solve this problem.

In this study, we proposed to use buoy structure as a method which can be disconnected motions of two devices (as shown in figure 2). The mining robot is greatly influenced heave and pitch motion by the flexible pipe. A connection between the buoy structure and the mining robot is developed as a revolute joint type. The flexible pipe is attached at the buoy structure. The heave and pitch motion of the mining robot can be independently moved by this mechanism. Dynamic analysis is fulfilled for verification of this mechanism.

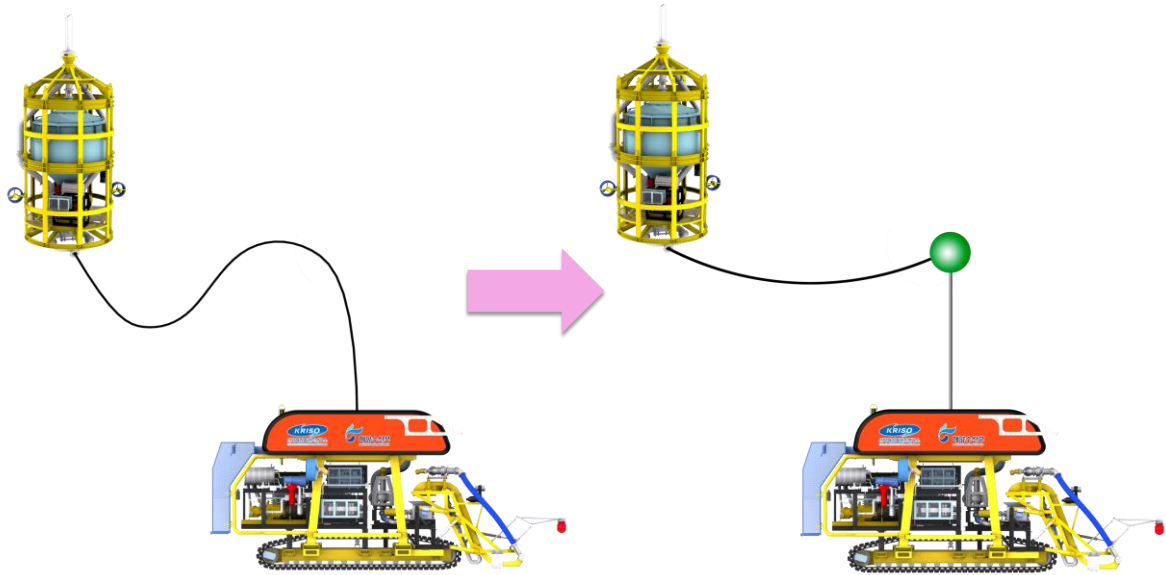


Figure 2: Conceptual diagram for decoupled motion of the tracked vehicle and the long flexible riser using the buoy

## References

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