A Development of a Docking Aid and Tightening System for FSRUs and LNGCs

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ABSTRACT
An onshore receiving terminal provides precise docking information to the pilot by detecting distance, speed, and angle of docking LNGC using the laser or ultrasonic distance measuring device installed to fixed mooring facility. However, FSRU is on the status that mooring facility is moved to floating LNG terminal which is installed to the seabed by the influence of weather conditions such as sea wind and ocean current, and therefore, it is hard to use existing distance measuring device, and a LNGC (Liquefied Natural Gas Carrier) comes alongside a FSRU (Floating Storage Regasification Unit) for off-loading. It is critical to maintain the tension of the mooring line between FSRU and LNGC, because LNG may be in danger of leakage and possible explosion during off-loading. This article aimed to develop docking aid system between two vessels fluids such as FSRU and LNGC based on docking guidance system technology of floating offshore LNG terminal, and a tightening control, monitoring system and algorithm was developed for the side-by-side mooring. In comparison with previous systems, they are expected to provide stably docking and control the tension of the mooring line between a FSRU and a LNGC.

KEY WORDS: Docking Aid System, Portable Pilot Unit, Moving-Based RTK-GPS, Docking Distance, Docking Speed, Berthing Distance, Berthing Angle, and Side by Side Mooring

INTRODUCTION
An effective and stable docking aid and tightening system is necessary for a liquefied natural gas carrier (LNGC) to dock on a floating storage regasification unit (FSRU) and to offload there [1]-[4]. In the case of the existing docking aid system, pilots personally lead LNGCs to the FSRU by using the differential global positioning system (DGPS) or laser or ultrasonic rangefinder. As the case stands, it rests upon pilots’ experience and judgment, and therefore it is realistically difficulty to assure safe and exact docking [5]. Moreover, carriers are off-loaded without tension control after pretension control [6]. Here at, this study was conducted to develop a new docking aid system combined with moving-based real time kinematic-global positioning system (RTK-GPS) and a new tightening system that makes it possible to situate the winch simultaneously with the quick release hook (QRH) and thus enables integrated remote control. The developed system improved repetitive positioning accuracy (within 10cm) and secured the safety of the tightening system.

DOCKING AID AND TIGHTENING SYSTEM
System Configurations
As shown in Fig. 1 the docking aid system is composed of a FSRU bridge server set up on the FSRU, a large docking display board, an image transmitter that shows the docking process, and a FSRU pilot unit. A LNGC is equipped with a LNGC pilot unit and a mobile-based docking monitoring system through which the pilot and the captain can monitor the docking process in real time. The tightening system is composed of a sensor module that detects information on the distance between a FSRU and a LNGC, a local control unit that obtains and processes information on side by side mooring tension and on the distance between vessels, a quick release system, and a winch system that adjusts mooring tension to the given value. Information on the distance between vessels and on mooring distance, acquired through the local control unit (LCU), is transmitted by a data transmitter (Optical MODEM, FOCAL907) to the main control unit in real time and is used as data to monitor the docking process and tightening control.