

자율운항선박 육상원격제어시스템 추진사항 및 한계

노화섭* · 예병덕** · † 임정빈

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요약 : 자율운항선박의 비상상황시 육상원격제어시스템의 개발의 현재까지의 원격제어, 원격모니터링, 통신시스템에 대한 개발 결과를 분석하고 향후 효율적인 개발 방향을 제시하고자 한다.

핵심용어 : 자율운항선박, 육상원격제어시스템, 비상상황

원격제어 시스템 개발 목표

▶ 개발 개요

구분	내용
과제명	자율운항선박 기술 개발 (자율운항선박 비상상황 육상원격제어 기술과 (비상상황, 통신, 서비스 견출) 시나리오 및 사이버보안 기술개발)
총 연구기간 / 당해년도	2020.04 ~ 2024.12 (4년 9개월) / 2021.01 ~ 2021.11.2
개발 대상 기술 개요	  <ul style="list-style-type: none"> ▶ 자율운항선박 비상시 상황별 시나리오 구축 ▶ 시나리오 기반 원격제어시스템 개발 ▶ 원격제어를 위한 통합 네트워크 SW 개발 ▶ 원격운영 기반기술과 상황인식시스템 모델 평가
관련별 연구내용	<ul style="list-style-type: none"> ▷ (한국해양대) 비상상황 시나리오 구축, 해상실증 ▷ (유지연대) 육상원격제어시스템 개발 ▷ (SK에이앤지) 원격모니터링 시스템 개발 ▷ (씨아이5) 데이터 통합처리 네트워크 SW개발 ▷ (선박해양플랜트연구소) 상황인식시스템개발
목표	<ul style="list-style-type: none"> ▶ 비상상황 3종 (충돌, 충돌근접, 항로이탈) + 기타 ▶ 제어 거리 100 Km (LTE-M) 이내의 연안 ▶ MASS 위치 제어 정밀도 1.1LOA

연구개발 목표

- 최종 목표 : 자율운항선박 비상상황별 원격제어 시스템
- 연차별 개발 목표 및 내용

연차	연구목표	주요 연구내용
1차년도 (2020)	• 자율운항선박 육상원격제어시스템 설계와 검증	<ul style="list-style-type: none"> • 비상상황 시나리오 구축 • 원격모니터링 시스템 설계 • 원격제어시스템 설계 • 통신시스템 설계(이론설계) • 상황인식 모델용어 모델링 구조화
2차년도 (2021)	• 자율운항선박 육상원격제어 시스템 개발 및 평가	<ul style="list-style-type: none"> • 비상상황 시나리오 평가 • 원격모니터링 단위시스템 개발 • 원격제어 단위시스템 개발 • 통신시스템 설계(SW개발) • 상황 식별 알고리즘 개발
3차년도 (2022)	• 자율운항선박 통합시스템 구축과 실증	<ul style="list-style-type: none"> • 비상상황 시나리오 실증 • 원격모니터링 시스템 실증 • 통합상황인식 원격제어시스템 개발과 검증 • 통신시스템 개발과 검증 • 통합상황인식시스템 개발
4차년도 (2023)	• 자율운항선박 육상원격제어시스템 구축	<ul style="list-style-type: none"> • 비상상황 시나리오 평가 • 원격모니터링 시스템 해상실증 • 육상원격제어 원격제어시스템 해상실증 • 통신시스템 검증 및 실증 • 상황인식 모델용어 개발
5차년도 (2024)	• 자율운항선박 육상원격제어시스템과 타 시스템의 연동 및 실증	<ul style="list-style-type: none"> • 비상상황 시나리오 타시스템 연동 • 원격모니터링 시스템 연동 및 해상실증 • 육상원격제어 원격제어시스템 개발과 실증 • 통신시스템 검증과 실증 • 상황인식 모델용어 실증

현재까지 기술개발 결과

- 비상 상황 시나리오 개발

1. 비상상황 시나리오 평가방법 개발
 - 1) 원격제어모델과 시스템 지연모델 개발
 - ① 육상제어자 만족도 : 전문가 활용을 통한 만족도 조사(설문 등)
 - ② 시스템 응답시간 : SRC-MASS 간의 응답시간 측정(제어시간, 육상제어자 반응시간, 지연 시간 등 포함)
 - ③ 선박제어성능 : 선박 조정 성능(속력, 선수방위, 타각)
 - ④ 항로유지/변경성능 : 선박길이 1.1배 내에서 제어가능여부 및 이격거리(m)
 - ⑤ 비상대응가능성능 : 비상상황 발생~상황종료까지 소요시간
 - 2) 항해자 선박조종 패턴 식별(HMM 기반)
2. 시나리오 연계 단위 시스템 평가
 - 1) 원격제어 모델 기반 단위 시스템 실결과 평가
 - 2) 각 공동/협동 기관과 공조하여 진행(해상실증)
3. 단위 시스템 통합 시나리오 평가
 - 1) 단위 시스템 각각에 대한 평가
4. 타 과제 연계 - 타 과제 연계 고려

현재까지 기술개발 결과(계속)

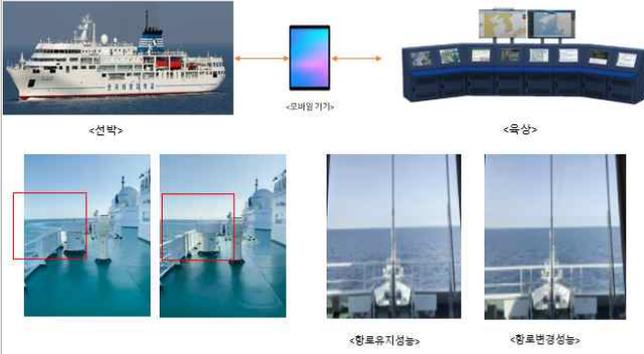
- 실증테스트
 - 선박-육상 간 성능평가 실시

	1차 연안항해(제주)	2차 연안항해(무기함)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
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현재까지 기술개발 결과(계속)

- 실증테스트
 - 선박-육상 간 성능평가 실시



현재까지 기술개발 결과(계속)

- NMS 프로토타입 개발



<그림> SNMP 기반 NMS 프로토타입 GUI 예시

- 실증용 NMS 프로그램 개발
 - 자체 시뮬레이션 센터를 활용한 네트워크 데이터수집/분석
2. 통신망 테스트베드 구축
 - LTE / LTE-M 라우터를 이용한 테스트베드 구축 및 통신망 테스트
 - LTE - VSAT 네트워크 통신망 전환 테스트
 3. 통신시스템 대모 시연
 - 무선 통신망 지연테스트 및 최적화 연구

원격제어시스템 개발 추진 계획

▶ 원격제어시스템 개발 목표와 주요 내용 : 육상원격제어시스템 개발 및 평가

세부 연구개발 목표	세부연구개발 내용 및 범위
세부 1 비상상황 시나리오 평가	1. 비상상황 시나리오 평가방법 개발 2. 시나리오 연계 단위 시스템 평가 3. 단위 시스템 통합할 시나리오 평가
세부 2 원격모니터링 단위시스템 개발	1. 선박 원격 모니터링 시스템 개발 2. 항만 원격 모니터링 시스템 개발 3. 통신연계 원격모니터링 시스템 검증
세부 3 원격제어 단위시스템 개발	1. 육상 제어 시스템(HW, SW) 개발 2. 선박 제어 시스템(HW, SW) 개발 3. 원격제어 시스템 검증 3. 네트워크(HW, SW) 개발 5. 네트워크 시스템 검증
세부 4 통신시스템 개발	1. SNMP 기반의 NMS(Network Monitoring System) 개발 2. 통신망 테스트베드 구축 3. 통신시스템 대모 시연
세부 5 상황 식별 알고리즘 개발	1. 원격 상황 식별 데이터 구조 설계 2. 전처리 SW 설계 및 구현 3. 상황 식별 알고리즘 개발

- ▶ 단위 시스템 보완 및 평가/인증
- ▶ 데이터 지연속도 분석

사 사

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현재까지 기술개발 결과(계속)

- 원격제어시스템 소프트웨어
 - 운항 모니터링 영역, 제어 모니터링 영역으로 구분



선박 운항상태 모니터링 영역

선박 제어 및 네트워크 모니터링 영역