53 New Development of Unmanned Construction ~Realization of Remote Operated Working System in Shallow Water Area~

Principal Investigator: Shin'ichi Yuta (President, New Unmanned Construction Technology Research Association)

Collaborative Research Groups: New Unmanned Construction Technology Research Association

R&D Objectives and Subjects

Background

- Remote/Unmanned Construction is an unique technology which is developed in Japan for emergency construction in an eruption or earthquake disaster.
- Recently, water disasters (landslides, debris flows, floods) have occurred frequently because of torrential rain.

- An amphibian heavy carrier robot is requited for post-disaster restoration work at river edges or semi-underwater places.

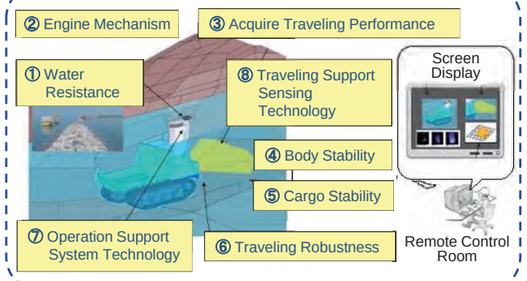
R&D Objectives

Expand applicable scope of unmanned construction to dangerous river edges and shallow water areas for the quick post-disaster restoration of frequently occurring water disasters

R&D Subjects

- Construct an unmanned construction system which realizes the series of post-disaster restoration work at river edges or semi-underwater places at a depth of about 2 m.
- Develop remotely operated heavy carrier robot which runs efficiently and stably under various conditions in several hundred meters from shallow water to land areas.

【Concrete R&D Subject】



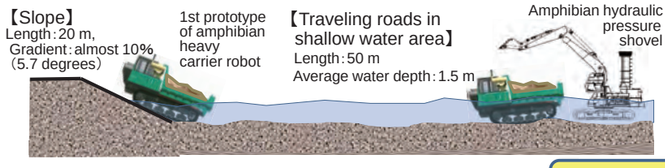
Current Accomplishments (1/2)

I. Development of the Semi-underwater Heavy Carrier Robot

R&D Achievement (H26～28):
Development of 2nd prototype remote operated type heavy carrier robot based on the evaluation of 1st prototype which runs in semi-underwater area.

【Experiment which images the removal of dirt of river channel vessel occlusion】

- Excavated earth and sand: 6.0 m³ Bucket ×5 times=Almost 7.0t capacity
- Underwater traveling: 2.0 km/h, water depth 1.5m, traveling distance about 50m



【Water Resistance Test】

【Land Travel Test】

【Driver Seat Submerge Test】【Suction & Exhaust Test】

Reflection of Experiment Results

Reflection of Experimental Results

Remote Operated Type Heavy Carrier Robot (2nd Prototype)

- Engine with a waterproof bulkhead
- Utility part with submersion measures
- Leakage sensor in bulkhead
- Overheating measures
- Submersion measures of electrical components, rigging
- Mounting of suction & exhaust snorkel
- Mounting of remote operation system
- Maximum water depth of traveling : 1.8 m
- Maximum load : 10t

Current Accomplishments (2/2)

Ⅱ. Development of Remote Operation Support and Guidance System for Semi-underwater Traveling

R&D Achievement (H26～28)

【Development of Remote Operation Guidance System Using GNSS-IMU】

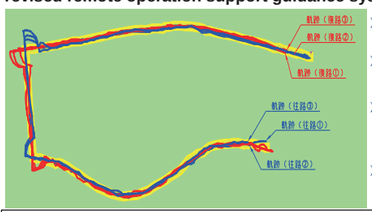
The following improvements and experiments are executed in H28 for the better operationality in the operation screen of the operation guidance system

①Transmitted carrier body
(for better visibility of planned trajectory)
②Rectangle display of traveled trajectory
(for easy recognition of traveling direction)
③Addition of circumferential scene
(for improvement of operationality on land)

Test road for the experiments

Revised display screen of remote Operation support guidance system

Results of on land traveling comparison test using revised remote operation support guidance system

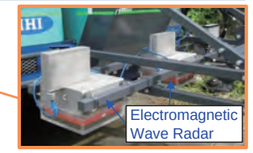


- Planned travel course (goal point)
- Position and orientation of remote operated heavy carrier robot (moving point)
- Absolute position data is measured by RTK-GPS positioning method of GNSS system
- Traveling direction and body tilt angle are measured by IMU.

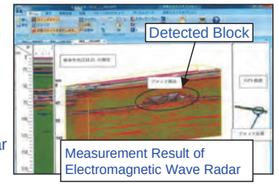
The error of real trajectory from planned trajectory was a maximum 50 cm using a revised remote operation support guidance display system.

【Development of a recognition technology for traveling course soil conditions at underwater places】

Experiment of traveling course soil condition recognition using electromagnetic wave radar is executed to compensate for camera image in H28.



Blocks (height 20 cm) in the underwater traveling course are measured by electromagnetic wave radar



- Carrier position data and measurement result are linked and displayed on the traveling course soil condition.

Information Service System for Operator
- Sensor which compensates for the camera image
- Operational support (guidance) based on self-position measurements

H29～30: These achievements will be integrated into the semi-underwater carrier robot and evaluated in the actual field

Goals

(At the end of SIP Project): Increase the toughness of the country

【Development Goals】

Semi-underwater Carrier Robot
1. Water-running abilities:
- Maximum load:10t
- Travel speed:3 km/h
- Gradeability:10%
- Gradient(Right and Left): 3 degrees
- Overcome step: 20 cm
- Continuous traveling distance: 200 m

2. Features of Remote Control
- Wireless remote control
- Implementation of remote-control operational support interface

Realization of Unmanned Construction in Semi-underwater
- Building a model system.

【Representational utilities under disaster】

Example of Disaster expansion prevention in unmanned construction

Conventional remote-controlled underwater backhoe

- Excavating underwater earth that could block rivers.
- Excavating watercourses.
- Installing foot protection blocks to prevent levee collapses and so on.

The Semi-underwater Carrier Robot we developed

- Carrying earth, debris, etc.
- Carrying foot protection blocks, etc.
- Carrying equipment.

【Social Implementation: Expected System for Disaster Coping】

Possessor and User
- MLIT／Regional Development Bureau／technical office
- Local governments
- River administrators
- Private Company e.g. construction and rental firm
- Research Institute (broaden the scope of application and their evaluation)

Management system for use
- Possessor: operation planning／storage ／transportation／regular maintenance
- User: on-site／education of operator(usage, safety) ／daily check

【Common and regular use for their diffusion and maintenance (under consideration)】

Regular Usage
(Use as an amphibian carrier: Mainly by on-board operation)
- Dredging and revetment construction of rivers and lakes
- Disaster prevention construction at rivers, lakes and coastlines

Common system for regular usage and in a time of disaster
- Maintain semi-underwater carrier and remote operation system, separately
- Construct system under the initiative of central and local governments

Expansion of the number of their service, production and sales
- Consideration of the rental and lease system for regular use
- Overseas deployment (Export carriers and their operation techniques)