Study on a Boat-based Regional Coral Monitoring (Abstract of the Final Report)

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1. Introduction

Hermatypic corals are important species of organism for tropical coastal environments. They play a key role as primary producers in the oligotrophic waters by zooxanthella symbiosis. Their skeletons are contributed to the tropical coastal topography over a long period of time.

It is reported that risks of corals such as bleaching or mortality are increased due to the global climate change[1)], and they will be expected to keep increasing in the future[2)]. Additionally, southern corals are shifted to the temperate zone with increasing the minimal sea temperature in the winter[3)]. Regional coral monitoring is growing importance.

Typical coral observation methods are diving investigation and remote sensing. Diving investigation is able to cover only small areas of observation points, though its investigation results are detailed. Satellite remote sensing can cover over large areas, but it is unable to identify individual coral colony because the highest resolution of the multi-spectral satellite imageries is around a few meters. A boat-based observation is expected to cover an intermediate resolution and intermediate coverage area for coral monitoring between diving investigations and satellite remote sensing.

2. Research Objective

The final goal of this study is to evaluate the impact of global climate change to the coral reef ecosystem. For that purpose, firstly, we develop boat-based coral observation methods. Secondly, we conduct the boat-based coral observation in coral habitat sea area. Finally, coral observations will be operated in more than 5 sea areas in Japan, and large quantities of coral distribution data will be compiled in the GIS database.

3. Research Method

(1) Development of the torpedo-shaped-buoy to fit the fluorescence imaging lidar in for observation of coral viability.
(2) Development of the autonomous self-propelled mini boat based stereo camera system for coral observation in three dimensions.
(3) Regional coral observations in 5 sea areas by boat-based observations.

We have developed the towed buoy-based fluorescence imaging lidar system (Fig. 1 right), and the autonomous mini boat-based stereo camera system (Fig. 1 center), as well as the glass-bottom-boat based fluorescence imaging lidar system (Fig. 1 left). The list of the boat-based observations operated in FY2012-2014 is shown in Table 1.

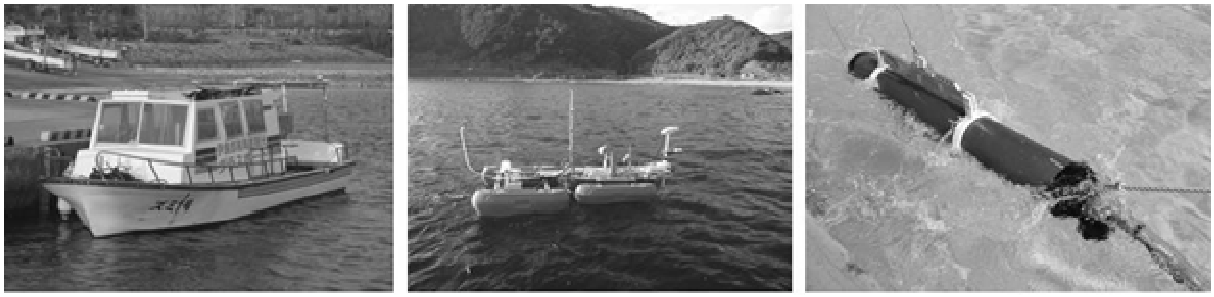

Fig. 1: Photographs of the boat-based coral observations.
(left) the glass-bottom-boat based fluorescence imaing lidar system
(center) the autonomous self-propelled mini boat-based stereoscopic-imagery system
(right) the towed buoy-based fluorescence imaging lidar system

Table 1: List of the boat-based coral observations in FY2012-2014
(Lidar & Stereo-camera contemporary observation)

observation period	place	system
Jan.28 – 30.2014 Jan.24 – 25.2015	Taketomi Island, Yaeyama, Okinawa	Boat-towed Lidar Buoy & Autonomous mini-Boat (2014, 2015)
Oct.28 – 31.2013	Shimoji Island, Miyakojima, Okinawa	Glass-bottom-Boat & Autonomous mini-Boat (2013)
Nov.28.2012 Dec.3 – 5.2014	Tatsukushi Marine Park, Tosashimizu, Kochi	Boat-towed Lidar mini-Boat & Manned mini-Boat (2012) Boat-towed Lidar Buoy & Autonomous mini-Boat (2014) (contemporary observation with underwater Quadrat investigation)
Sep.18 – 19.2014	Kushimoto Marine Park, Higashimuro,Wakayama	Boat-towed Lidar Buoy & Boat attached underwater camera system (2014) (contemporary observation with underwater Quadrat investigation)
Nov.9.2012 Oct.30.2014	Banda, Tateyama,Chiba	Boat-towed Lidar mini-Boat (2012) Boat-towed Lidar Buoy (2014)

4. Results

We have obtained regional coral observation data by the fluorescence imaging lidar system and the stereo camera system. Fig. 2 shows the reconstructed results of the seabed video data at the quadrat point (3m x 3m) in Tatsukushi Marine Park. Fig.3 shows the example of the video images and the fluorescence lidar images observed by the towed buoy based fluorescence imaging lidar system in Taketomi island. Fig.4 shows the live coral distribution around Taketomi island observed by the towed buoy based fluorescence imaging lidar system.

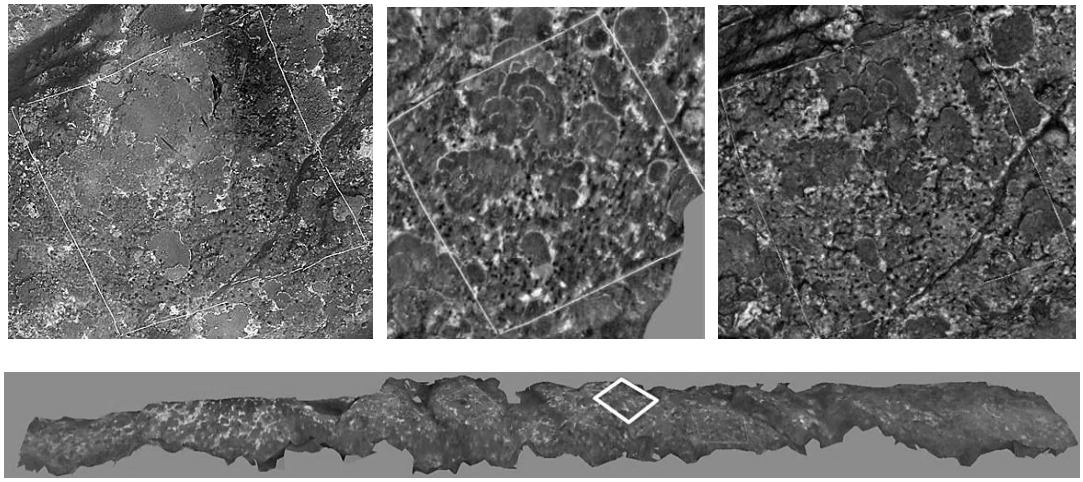

Fig.2　Reconstructed results of the seabed video data
at the quadrat point (3m x 3m) in Tatsukushi Marine Park.
Upper Left: 2014 Dec., Center: 2013 Dec., Right: 2012 Nov.
Lower: Large seabed 3D map (67 m long) reconstructed by 5 survey lines.
Boxed area indicates the quadrat point.

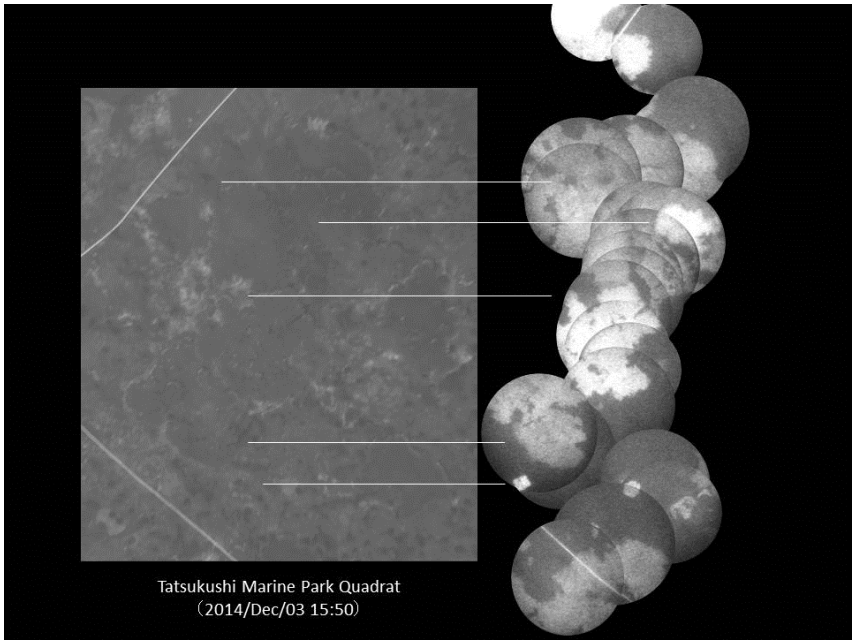

Fig.3　An example of the video images and fluorescence lidar images
observed by the towed buoy based fluorescence imaging lidar system
in Tatsukushi Marine Park (2014.Dec.3).
(left) video image, (right) fluorescence lidar image

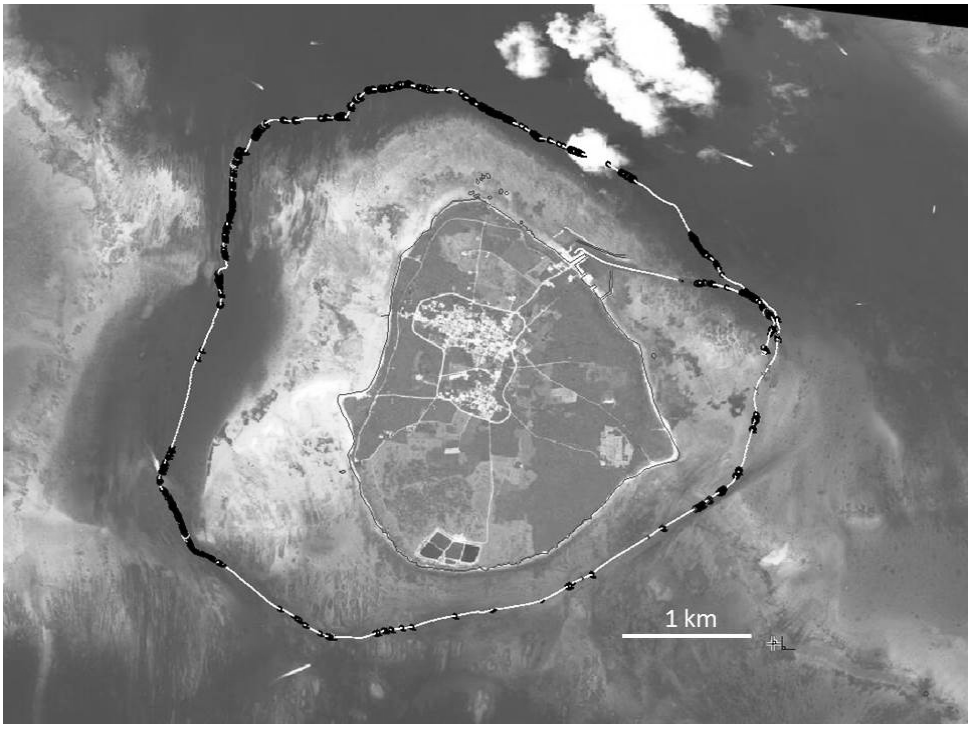

Fig.4　Live coral distribution around Taketomi island
observed by the towed buoy based fluorescence imaging lidar system.
(2014.Jan.30 10:29-12:33)
black ▼ mark: live branch type coral,
black ● mark: live table type coral,
gray × mark: dead coral rubble,
the background is high-resolution satellite imagery (World Vew-2, 2010.Aug.14)

5. Discussion

New boat-based coral observation methods have been developed in this study. It have been confirmed that the autonomous self-propelled mini boat based stereo camera system can provide the seabed 3D imagery, which makes it possible to judge the growth of coral colonies. Additionally, it have been confirmed that the towed buoy based fluorescence imaging lidar system can provide the live coral distribution data in 10-km survey line scale, which makes it possible to judge the regional mortality of coral community.

Reference

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