EVALUATION OF THE FEASIBILITY OF WEB CAMERAS TO MONITOR COASTAL AREAS

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ABSTRACT:

Global and regional environmental changes can cause serious effects on coastal areas. Web camera has an effective possibility for the monitoring of these phenomena, because they can acquire continuous data in relatively large areas. This research is evaluating the feasibility of web cameras to monitor coastal areas (benthic cover of a coral reef and shorelines). Composite visible images were useful for decrease of effects of halation and wave, it was found that they were effective way of monitoring under water. We were able to extract waterline accurately using near-infrared images, it was found that they were effective way of monitoring the change of shorelines by rising sea levels and intensified typhoon activities.

1. INTRODUCTION

Global and regional environmental changes (global warming, extreme weather, terrestrial runoff, etc.) can cause serious effects on coastal areas. For example, coral bleaching is caused by combined stresses including rising sea temperatures and red soil runoff from the adjacent land. Moreover, shoreline changes are enhanced by rising sea levels and intensified typhoon activities. Several methods have been used to monitor these changes so far. In-situ monitoring includes observation of coverage of corals and seaweeds by snorkeling or diving and tracking shorelines by GPS (Global Positioning System) (Kayane et al., 2002; Harii and Kayann, 2003; Kench and Brander, 2006). These monitoring methods, however, are difficult to observe the changes in large areas with high frequency, though detailed examination is possible. On the other hand, large-scale monitoring includes mapping of coral reefs and shorelines by using aerial photographs and satellite data (Palandro et al., 2003, 2008; Yamano and Tamura, 2004; Yamano et al., 2006). These monitoring methods, however, are synoptic, and the accuracy is generally low. Web cameras could serve as a complementary method for these monitoring methods, because they can acquire continuous data in relatively large areas. In this study, we evaluate the feasibility of web cameras to monitor coastal areas (benthic cover of a coral reef and shorelines).

2. MATERIALS AND METHODS

2.1 Study site

Our study site is part of Sesoko Station, University of the Ryukyus, Japan (26º38'12"N, 127º51'54"E), which is located in the northern part of main island of Okinawa.

2.2 Data

To observe the coastal area, we installed a web camera (M12D, MOBOTIX AG, Germany) at the rooftop of a building (19 m a.s.l.). The web camera has two lenses and can capture visible and near-infrared images at the same time (Figure 1). The captured images were contained coral reefs, shorelines and seaweeds. We conducted the observation four times in several season (18-19 May, 13 July, 29-31 August 2009 and 20-22 February 2010).

Ground-truthing for benthic cover and shoreline positions was performed by observing coverage of corals and seaweeds with a quadrat and by tracing shorelines, respectively, during the camera monitoring.

Figure 1. Example of captured near-infrared (left) and visible (right) images.

2.3 Data analysis

We produced 1-hour composite images to remove effects of halation and wave. The composite was based on minutely images with the highest digital number (DN) value of an individual pixel, because the DN value of the pixel influenced halation and wave decreased.

We picked up DN values around water areas from near-infrared image and made a histogram of these DN values. We used the maximum value around the tracing shorelines to define the threshold value for delineating the land-water boundary (waterline). The waterlines were extracted as contours from the threshold value.

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3. RESULTS AND DISCUSSION

3.1 Composite images

Figure 2 shows composite visible images from 13:00 to 13:59 local time (a total of 60 images) at 19 May, 13 July, 29 August 2009 and 21 February 2010. Visibilities under water of composite images were different from the weather conditions. We were able to confirm patches of coral and seaweed more clearly in the clear days (13 July 2009 and 21 February 2010) than the cloudy days (19 May and 29 August 2009). However, we confirmed decrease of effects of halation and wave by using composite images compared to original images. Moreover, the distribution of coral and seaweeds obtained from ground verifications and the image analysis is corresponding, then it was found that composite images was effective way of monitoring under water.
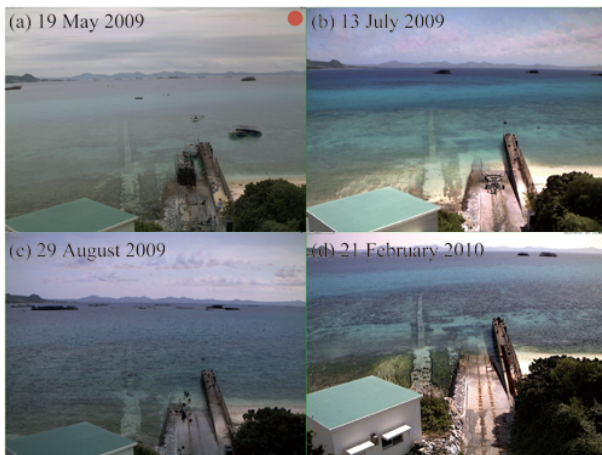

Figure 1. Composite visible images from 13:00 to 13:59 local time at (a) 19 May, (b) 13 July, (c) 29 August 2009 and (d) 21 February 2010.

3.2 Extracting the waterline

Figure 3 shows histogram of digital numbers (DN) values around water areas of the near-infrared image captured on 21 February 2010. We decided that the threshold value was 246 (DN) as the maximum value around the tracing shorelines. It is clear that the threshold value can delineate the land-water boundary (waterline). Moreover, we extracted the waterlines as counters from the threshold value, and the mean error between extracted waterline and ground-truthing tracing shoreline was 1.3 pixels (about 30 cm). Therefore, the monitoring using near-infrared images was effective for detection of waterline.

4. CONCLUSION

This research is evaluating the feasibility of web cameras to monitor coastal areas (benthic cover of a coral reef and shorelines). Composite visible images were useful for decrease of effects of halation and wave, it was found that composite visible images were effective way of monitoring under water. We were able to extract waterline accurately using near-infrared images, it was found that near-infrared images were effective way of monitoring the change of shorelines by rising sea levels and intensified typhoon activities.
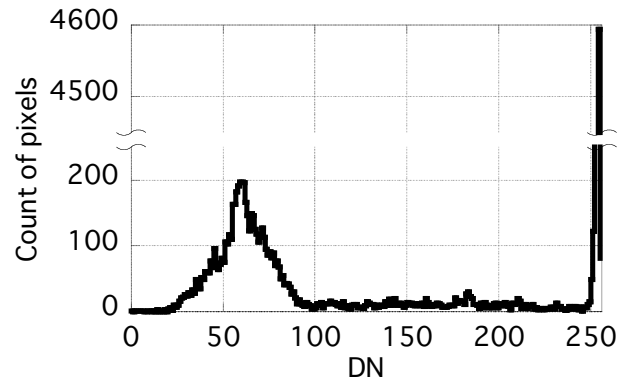

Figure 2. Histogram of digital numbers (DN) values of the near-infrared image captured on 21 February 2010.

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