9. Wang, Z., Jiang, M., Hu, Y., Li, H.: An incremental learning method based on probabilistic neural networks and adjustable fuzzy clustering for human activity recognition by usingwearable sensors. IEEE Trans. on IT in Biomed. **16**, 691–699 (2012)
10. Gyllensten, I.C., Bonomi, A.G.: Identifying types of physical activity with a single accelerometer: evaluating laboratory-trained algorithms in daily life. IEEE Trans. on Biomed. Eng. **58**, 2656–2663 (2011)
11. Wang, N., Redmond, S.J., Ambikairajah, E., Celler, B.G., Lovell, N.H.: Can triaxial accelerometry accurately recognize inclined walking terrains? IEEE Trans. on Biomed. Eng. **57**, 2506–2516 (2010)
12. Muscillo, R., Schmid, M., Conforto, S., Alessio, T.D.: An adaptive kalman-based bayes estimation technique to classify locomotor activities in young and elderly adults through accelerometers. Medical Engineering & Physics **32**, 849–858 (2010)
13. Guo, Y.W., Liu, G.Z., Huang, B.Y., Zhao, G.R., Mei, Z.Y., Wang, L.: A pilot study on quantitative analysis for table tennis block using a 3D accelerometer. In: Information Technology and Applications in Biomedicine, Corfu (2010)
14. Ahmadi, A., Rowlands, D.D., James, D.A., Ahmadi, A.: Investigating the translational and rotational motion of the swing using accelerometers for athlete skill assessment. In: Sensors, Daegu (2006)
15. Kiang, C.T., Yoong, C.K.: Local sensor system for badminton smash analysis. In: IEEE Intl' Instrumentation and Measurement Tech. Conf., Singapore (2009)
16. Pernek, I., Stiglic, G., Kokol, P.: How hard am i training? Using smart phones to estimate sport activity intensity. In: IEEE Intl' Conf. on Distributed Comput. Syst. Workshops (2012)

# A Simple and Non-invasive Measurement Method Important for Conserving Large Animals Underwater

**Tadamichi Morisaka, Mai Sakai, Kazunobu Kogi and Hiromitsu Hama**

**Abstract** This paper shows how simple, non-invasive measurement method is important for conserving large animals living underwater. We have studied free-ranging wild Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) around Mikura Island, Japan for about 15 years. We usually observe dolphin behavior and record acoustics underwater including photo-identification of every dolphins. Despite lots of video data, more basic information such as body size have lacked. In order to measure body size of the animals non-invasively, we used commercial measurement software which can measure the distance between two points on 3D photos by commercial 3D camera. Accuracy evaluation tests using a tape measure between 15 and 250 cm were conducted at the field site (Mikura Island) and the errors were within 5 % of the actual sizes. We successfully measured body size of 33 free-ranging wild dolphins. Mean absolute percentage error of the same individuals in different photos was within 4 % for dolphins. The average size of the adult dolphins was 249.6cm, which was the similar to the average actual size of 4 by-caught dolphins of the population (251.7 cm). We also opportunistically measured green turtles (*Chelonia mydas*) during our dolphin survey. Mean absolute percentage error of the same individuals in different photos was within 2 % for turtles. The average straight carapace length (SCL) of the 14 turtles was 48.3 cm

T. Morisaka(✉)
Tokai University Institute of Innovative Science and Technology, Shizuoka, Japan
e-mail: chaka@tokai-u.ac.jp

M. Sakai
Faculty of Agriculture, Kinki University, Nara, Japan

K. Kogi
Mikura Island Tourist Information Center, Tokyo, Japan

H. Hama
R&D Center of 3G Search Engine, Incubator, Osaka City University, Osaka, Japan





T.T. Zin et al. (eds.), *Genetic and Evolutionary Computing*,
Advances in Intelligent Systems and Computing 387,
DOI: 10.1007/978-3-319-23204-1_12

(37.9 – 67.7 cm), which is much smaller than the adult green turtle length (80 – 111 cm). A simple measurement method is thus important to know the size of the large animals underwater, which indicates animal age and health condition, and are important for conserving these large animals.

## 1 Introduction

Large animals underwater usually suffers from their extinction. For example, green turtles (*Chelonia mydas*) and loggerhead turtles (*Caretta caretta*) which can be seen around Japan are classified as Endangered in IUCN Red List. The declaration of functional extinction of Yangtze River dolphins (*Lipotes vexillifer*) is still fresh in memory [1]. Such large animals decreased their number by human direct catch, bycatch by fishing gears, and habitat disappearance. Several species, such as Leatherback turtles (*Dermochelys coriaces*) and Vaquita (*Phocoena sinus*) are classified as Critically Endangered in IUCN Red List, and still suffering extinction.

How do we conserve such large animals? It is of course important to decrease direct catch, bycatch, and habitat disturbance of the animal. Also population monitoring is important to find harmful change of the animal population. To monitor population health, basic information should be measured, such as number of the animals in the population, home range or habitat range of the animals, and body size of the animals. If we monitor the trends of these information and detect harmful change, then we are able to move quickly to reduce such harmful effects.

Body size of the animal is the most basic information same as our health examination. Growth rate and/or nutritional status can be measured using accumulation of body size information through several years. In spite of such an important information, it is difficult to measure body size of free-ranging wild large animals, especially underwater. Researchers usually obtain the body sizes of the aquatic large animals from dead animals at beach, stranded animals, by-caught animals, and temporally captured animals. For example, researchers temporally captured bottlenose dolphins in the waters near Sarasota, Florida from 1970 [2] not only to measure body size, but also to take blood sample, tooth (for age estimation), and to acquire an ultrasonic diagnosis for checking pregnancy. Such temporal capturing projects bring basic scientific information in detail, but it needs lots of time, money and hands to capture wild dolphins, and dolphins get stress from capture.

We have studied free-ranging wild Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) around Mikura Island, Japan for about 15 years. At the field site, we basically record dolphin behavior and acoustics underwater including photo-identification of every dolphins using underwater video system [3-9]. In spite of lots of video footage and publications, we do not have basic information about these dolphins, especially body size. How large are they? How large are the neonates at birth? Is there sexual difference in size? What are the growth rate of the neonates, calves and subadults? These parameters are important not only for scientific knowledge, but also to conserve the population as we mentioned earlier.



It is too difficult for us to capture these dolphins temporally because 1) Mikura Island is an oceanic and small island which do not have any bay, beach and shallower water area; 2) commercial dolphin swimming program are conducted on this population during our study period; 3) we do not want to give stress to the dolphins from capture. We thus use commercial measurement software which can measure the distance between two points on 3D photos by commercial 3D camera in order to measure dolphin body size underwater. A simple, handy, light and field-usable system is needed for us biologists rather than accuracy.

We often observe green turtles during our observation of dolphins. No studies except one [10] have conducted on the rare green turtles which are classified as Endangered in IUCN Red List. We opportunistically took 3D photos using same measurement system to know their size, or for age estimation during our survey of dolphins.

## 2 Materials and Methods

### 2.1 *Subject Animals and Study Area*

We collected data from Indo-Pacific bottlenose dolphins residing around the shallower water off Mikura Island, Tokyo (139°36'E, 33°52'N), Japan from 23$^{th}$, June, 2014 to 2$^{nd}$, July, 2014. The dolphins have almost all been identified using natural marks on the body by underwater video-identification research since 1994 [11]. They are resident around Mikura Island throughout the year around, and about 120 dolphins were reside in 2014 [11, unpublished data]. We also opportunistically collected data from green turtles when we found them during our observation of dolphins.

### 2.2 *Calibration, Data Acquisition and Analysis*

We used simple 3D distance measurement system produced by Applied Vision Systems Corporation, Ibaraki, Japan. This system includes camera calibration program (AVSCalibForFUJI3DCam) and underwater calibration board for camera calibration, and 3D distance measurement software (AVS-Measure3D-F). We used FinePix Real 3D W3 (Fujifilm Corporation, Tokyo, Japan) with underwater housing (WHF-3DW3; NTF Corporation, Kanagawa, Japan) for taking 3D photos of the animals. The principle of the distance measurement, and calibration is shown in detail in the webpage of Applied Vision Systems Corporation (http://avsc.jp/technology/technology_principle.html; in Japanese).

We calibrated camera system (camera with underwater housing) at the Port of Mikura Island using the software and the calibration board. We took pictures from various angles and the software provided the calibration data. This calibration data was embedded in 3D distance measurement software. We then conducted accuracy evaluation tests using tape measure from 15 to 200 cm, and using a 250 cm rope at the Port of Mikura Island from various angles and distances.

We took 3D photos using the system which attached to our underwater video recording system (Fig. 1). When we spotted dolphins from the dolphin-swimming boat, we slowly approached the group and enter the water with the system. We used only fins, snorkels and masks without scuba diving equipment. If the dolphins came appropriate distance where whole dolphin body can be record within the camera flame, we took the photos. If the turtles were found at that time, we took the photos.

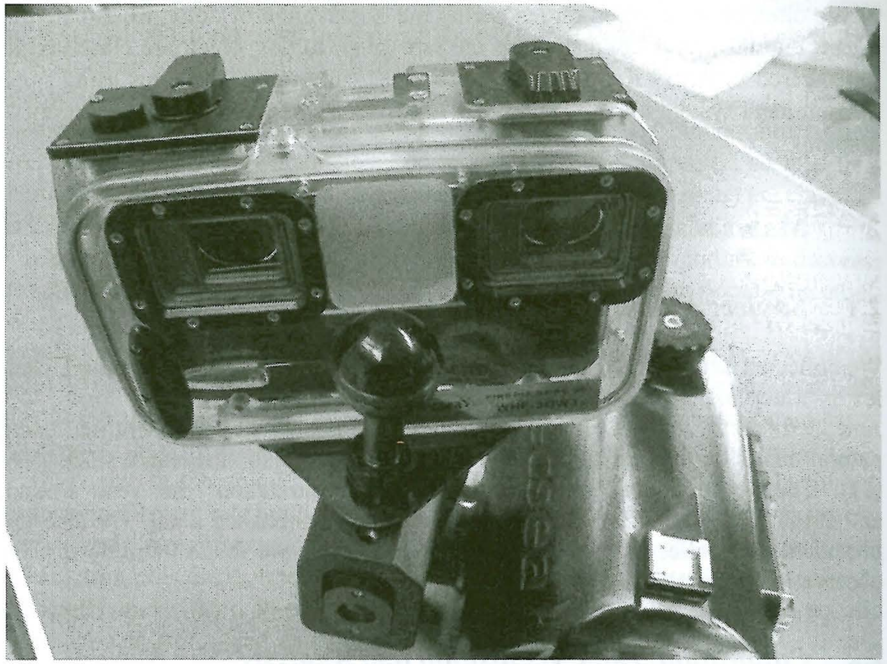

**Fig. 1** The camera system attached to the underwater video recording system

We used 3D distance measurement software to measure body size of the animals. We first identified dolphins using ID catalogue which was provided by Mikura Island Tourist Information Center. Then we measured standard length (straight line from the tip of the upper jaw to the fluke notch) of the dolphin body. We repeatedly measured (more than three times) dolphin body size of each pictures. After discarding obvious abnormal value, we averaged measurement values. Mean absolute percentage error of the same individuals in different photos was calculated to know the accuracy of the system using following equation;

$$M = \frac{1}{n}\sum_{t=1}^{n}\left|\frac{At-Ft}{At}\right| \times 100 \quad (1)$$

where M is the mean absolute percentage error, *At* is the actual value of the body size, and *Ft* is the average body size of each individuals. If the body seemed to be bend, we did not use that picture. For the body size of the green turtles, we measured



straight carapace length (SCL) which was measured from the anterior point at midline to the posterior notch at midline between the supracaudals [12].

# 3 Results

## 3.1 *Accuracy Evaluation Test*

Accuracy evaluation tests using tape measure between 15 and 250 cm at the Port of Mikura Island revealed that the measuring errors were within 5 % of the actual sizes (Fig. 2). Error % tended to become larger when the actual size became larger, but did not change along with the angle of the tape measure relative to the camera.

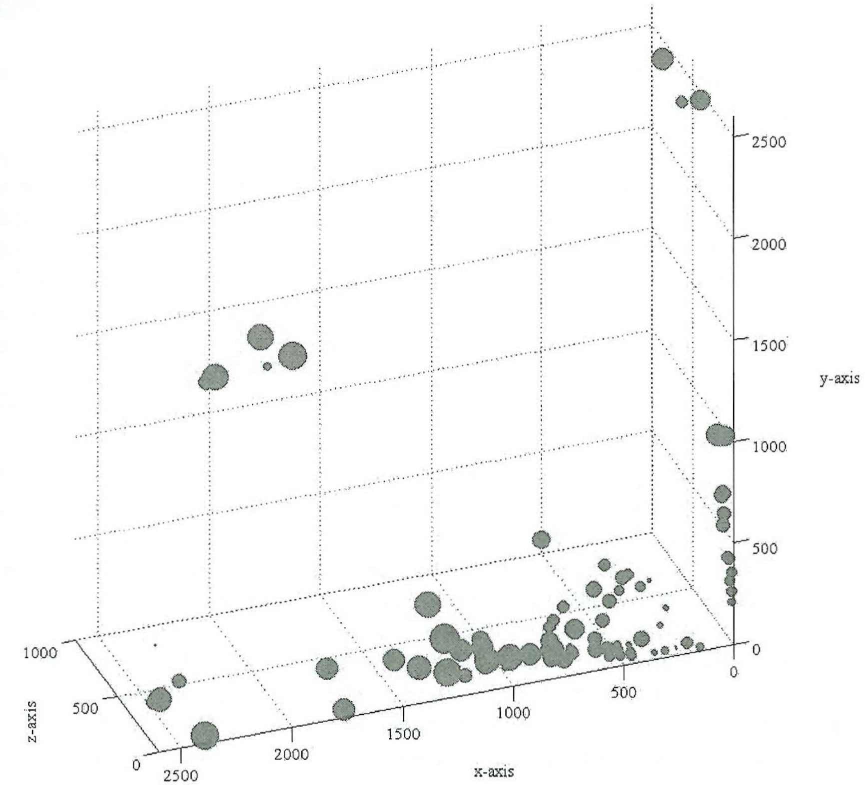


**Fig. 2** Three dimensional error distribution of accuracy evaluation test. Circles indicate error % (relative value) to the actual size, and circle locations indicate the end of the tape measure relative to the camera (another end is always the origin).

### 3.2 *Dolphin Body Size*

We successfully measured standard length of the dolphin body from 33 individuals. Seventeen dolphins were adult dolphins over 13 years. There was no significant difference between the estimated body size of the adult dolphins over 13 years old (249.6 ± 10.7 cm) and 4 by-caught adult dolphins over 13 years old from same population (251.7 ± 5.5 cm) (Wilcoxon/Kruskal-Wallis test; $\lambda^2$=0.07, $p$=0.79). Mean absolute percentage error of the 6 same individuals in different photos was within 4 % for dolphins.

### 3.3 *Turtle Size*

We successfully measured SCL from 14 individuals with 48.3 ± 10.2 cm (37.9 – 67.7 cm). Mean absolute percentage error of the 3 same individuals in different photos was within 2% for turtles.

## 4 Discussion

We successfully measured body sizes of free-ranging wild Indo-Pacific bottlenose dolphins and green turtles using simple and non-invasive underwater system within 5 % error to the body size. Although the error rate should be smaller, it still worth measuring body size of the free-ranging wild large underwater animals. The system was small, light and easy to use for the underwater researchers, and can use less than 40 m depth. In future, the accuracy of this system should be increased after finding correction equation per distance and actual size.

No significant difference was found between the measured adult size and the actual size of by-caught adults in dolphins. It suggested that the estimation was not abnormal but good. Wang et al. (2000) showed that Indo-Pacific bottlenose dolphin around Taiwan and other place were between 140 and 268 cm [13]. Our data were almost within this range, suggesting again that our estimation was not abnormal. We have no ecological information about the green turtles around Mikura Island so far. Minimum SCL size for the adult green turtle was reported 81 cm [14], so the turtles around Mikura Island seems immature individuals.

A simple measurement method is thus important to know the size of the large animals underwater, which indicates animal age and health condition, and are important for conserving these large animals. It is important to monitor such body sizes of the animals in order to detect harmful change, and will result quick move to reduce such harmful effects on the endangered animals.

**Acknowledgment** This research was supported by JSPS KAKENHI Grant Number 23310166 and partially 23220006. We are grateful to Yoshinori Hirose, Shingo Hirose, Michio Kurimoto, Nobuo Hirose, Masakazu Hirose, Soji Hirose, Yoshihiko Hirose, Ichiro Kurimoto, Kohei Omori, Naoki Hirose, Mitsuki Inoue, Shigemasa Hirose and Keiji Kato



for permission to board their boats without a fee. We also thank Toru Hishii, Mitsuko Hirose, Akihiko Hirose, Masamichi Kuroda, Isoko Kokatsu, Keiko Hirose, members of the Mikura Island Tourist Information Center, the MIDO team, and people living in Mikura Island for their support for conducting this study.

## References

1. Turvey, S.T., Pitman, R.L., Taylor, B.L., Barlow, J., Akamatsu, T., Barrett, L.A., Zhao, X., Reeves, R.R., Stewart, B.S., Wang, K., Wei, Z., Zhang, X., Pusser, L.T., Richlen, M., Brandon, J.R., Wang, D.: First human-caused extinction of a cetacean species? Biology Letters **3**, 537–540 (2007)
2. Read, A.J., Wells, R.S., Hohn, A.A., Scott, M.D.: Patterns of growth in wild bottlenose dolphins, *Tursiops truncatus*. Journal of Zoology **231**, 107–123 (1993)
3. Morisaka, T., Shinohara, M., Nakahara, F., Akamatsu, T.: Effects of ambient noise on the whistles of Indo-Pacific bottlenose dolphin population. Journal of Mammalogy **86**, 541–546 (2005)
4. Morisaka, T., Shinohara, M., Nakahara, F., Akamatsu, T.: Geographic variations in the whistles among three Indo-Pacific bottlenose dolphin *Tursiops aduncus* populations in Japan. Fisheries Science **71**, 568–576 (2005)
5. Sakai, M., Hishii, T., Takeda, S., Kohshima, S.: Laterality of flipper rubbing behaviour in wild bottlenose dolphins (*Tursiops aduncus*): caused by asymmetry of eye use? Behavioural Brain Research **170**, 104–210 (2006)
6. Sakai, M., Hishii, T., Takeda, S., Kohshima, S.: Flipper rubbing behaviors in wild bottlenose dolphins (*Tursiops aduncus*). Marine Mammal Science **22**, 966–978 (2006)
7. Sakai, M., Morisaka, T., Kogi, K., Hishii, T., Kohshima, S.: Fine-scale analysis of synchronous breathing in wild Indo-Pacific bottlenose dolphins (*Tursiops aduncus*). Behavioural Processes **83**, 48–53 (2010)
8. Morisaka, T., Sakai, M., Kogi, K., Nakasuji, A., Sakakibara, K., Kasanuki, Y., Yoshioka, M.: Spontaneous ejaculation in a wild Indo-Pacific bottlenose dolphin (*Tursiops aduncus*). PLoS ONE **8**, e72879 (2013)
9. Morisaka, T., Sakai, M., Kogi, K., Shinke, T., Zin, T.T., Hama, H.: A mobile measurement system for sound source level of wild dolphin whistles. Memoirs of the Faculty of Engineering, Osaka City University **54**, 25–29 (2013)
10. Morisaka, T., Sakai, M., Kogi, K., Kubota, S., Kamezaki, N.: A green turtle (*Chelonia mydas*) feeding on a jellyfish around Mikura Island, Tokyo, Japan. Umigame Newsletter Japan **89**, 15–16
11. Kogi, K., Hishii, T., Imamura, A., Iwatani, T., Dudzinski, K.M.: Preliminary demographic parameters and reproductive rates of Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) around Mikura Island, Japan. Marine Mammal Science **20**, 510–526 (2004)
12. Bolten, A.: Techniques for measuring sea turtles. In: Research and Management Techniques for the Conservation of Sea Turtles, pp. 1–5. IUCN/SSC Marine Turtle Specialist Group Publication, No. 4, Wachington, DC, USA (1999)
13. Wang, J.Y., Chou, L.-S., White, B.N.: Differences in the external morphology of two sympatric species of bottlenose dolphins (genus *Tursiops*) in the waters of China. Journal of Mammalogy **81**, 1157–1165 (2000)
14. Ishihara, T.: Life cycle. In: Natural History of Sea Turtles in Japan, pp. 57–83. University of Tokyo Press, Tokyo (2012)

# Advances in Intelligent Systems and Computing

Volume 387

**Series editor**

Janusz Kacprzyk, Polish Academy of Sciences, Warsaw, Poland
e-mail: kacprzyk@ibspan.waw.pl

*About this Series*

The series "Advances in Intelligent Systems and Computing" contains publications on theory, applications, and design methods of Intelligent Systems and Intelligent Computing. Virtually all disciplines such as engineering, natural sciences, computer and information science, ICT, economics, business, e-commerce, environment, healthcare, life science are covered. The list of topics spans all the areas of modern intelligent systems and computing.

The publications within "Advances in Intelligent Systems and Computing" are primarily textbooks and proceedings of important conferences, symposia and congresses. They cover significant recent developments in the field, both of a foundational and applicable character. An important characteristic feature of the series is the short publication time and world-wide distribution. This permits a rapid and broad dissemination of research results.



More information about this series at http://www.springer.com/series/11156

Thi Thi Zin · Jerry Chun-Wei Lin
Jeng-Shyang Pan · Pyke Tin
Mitsuhiro Yokota
Editors

# Genetic and Evolutionary Computing

## Proceedings of the Ninth International Conference on Genetic and Evolutionary Computing, August 26–28, 2015, Yangon, Myanmar – Volume I

Springer

*Editors*
Thi Thi Zin
Faculty of Engineering
University of Miyazaki
Miyazaki
Japan

Jerry Chun-Wei Lin
School of Computer Science and Technology
Harbin Institute of Technology Shenzhen Graduate School
Shenzhen
China

Jeng-Shyang Pan
College of Information Science and Engineering
Fujian University of Technology
Fuzhou
China

Pyke Tin
Faculty of Engineering
University of Miyazaki
Miyazaki
Japan

Mitsuhiro Yokota
Faculty of Engineering
University of Miyazaki
Miyazaki
Japan

ISSN 2194-5357 ISSN 2194-5365 (electronic)
Advances in Intelligent Systems and Computing
ISBN 978-3-319-23203-4 ISBN 978-3-319-23204-1 (eBook)
DOI 10.1007/978-3-319-23204-1

Library of Congress Control Number: 2015946740

Springer Cham Heidelberg New York Dordrecht London


Printed on acid-free paper

Springer International Publishing AG Switzerland is part of Springer Science+Business Media (www.springer.com)

# Preface

This volume composes the proceedings of the Ninth International Conference on Genetic and Evolutionary Computing (ICGEC 2015), which was hosted by University of Computer Studies, Yangon and was held in Yangon, Myanmar on 26–28, August, 2015. ICGEC 2015 was technically co-sponsored by Springer, Ministry of Science and Technology, Myanmar, University of Computer Studies, Yangon, University of Miyazaki in Japan, Kaohsiung University of Applied Science in Taiwan, Fujian University of Technology in China and VSB-Technical University of Ostrava. It aimed to bring together researchers, engineers, and policymakers to discuss the related techniques, to exchange research ideas, and to make friends.

93 excellent papers were accepted for the final proceeding. Three plenary talks were kindly offered by: Professor Chin-Chen Chang (IEEE Fellow, IET Fellow, Feng Chia University, Taiwan), Professor Yutaka Ishibashi (IEICE Fellow, Nagoya Institute of Technology, Japan), and Professor Jun Murai (Keio University, Japan). Prof. Jun Murai is known as the "Internet samurai" and, in Japan has also been called "the father of the Internet in Japan".

We would like to thank the authors for their tremendous contributions. We would also express our sincere appreciation to the reviewers, Program Committee members and the Local Committee members for making this conference successful. Finally, we would like to express special thanks for the financial support from University of Miyazaki, Japan in making ICGEC 2015 possible.

June 2015

Thi Thi Zin
Jerry Chun-Wei Lin
Jeng-Shyang Pan
Pyke Tin
Mitsuhiro Yokota