IOTC-2022-WPDCS18-20_Rev1 *(🡸 large revision)*

Recent trends in ICT and AI based fisheries information collection systems with mobile devices in Japan

(ICT : Information and Communication Technology)

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Special note : Questions and Comments

- We welcome questions & comments.
- Please provide to the Coordinator (Tom Nishida, currently in Namibia for SEAFO meetings) by e-mail at aco20320@par.odn.ne.jp
- This is because the coordinator needs to make sure to provide accurate & reliable answers and/or explanations by consulting with 3 Fishery IT companies in Japan.
- Then, the coordinator will provide replies to all WPDCS participants by e-mail.
- Thanks for your understandings!

Contents

1. Introduction

We have been developing **three different types** of ICT or AI based data collection systems for fisheries related information & sea conditions using mobile devices.

(ICT : Information and Communication Technology)

(1) ICT based GPS data logger

(2) AI based Fish species identification using Neural Network

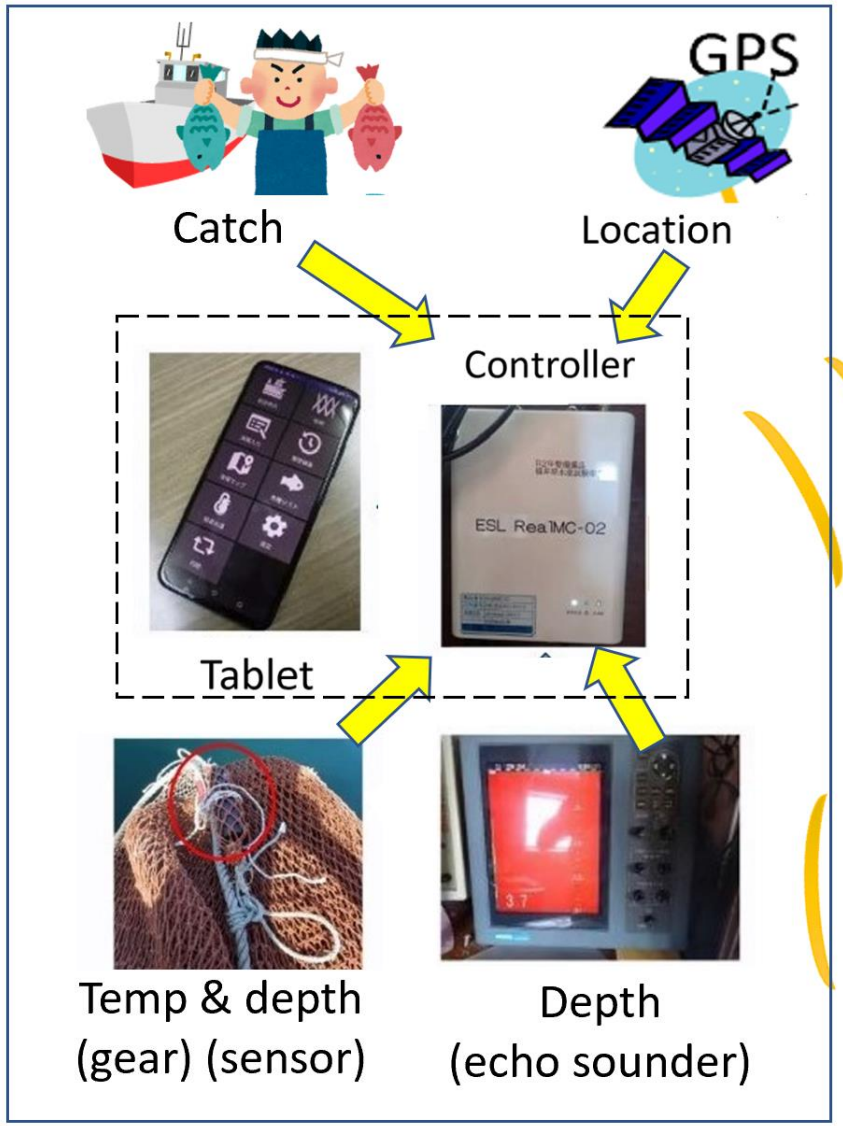
(3) AI based Fish size measurement using Neural Network

2. GPS data logger: what is it ?

Real-time data collection & transmission system for fisheries related information & sea conditions using a tablet connected to GPS, sensor & echo sounder on small coastal fishing vessels.

Data (catch, location, temp & dept) will be sent to the controller.

Tablet with menu will be used to manipulate various functions

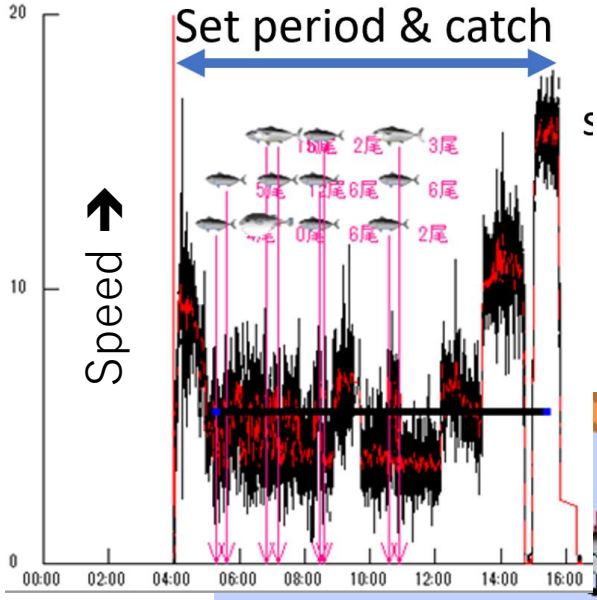


Cloud server (database)

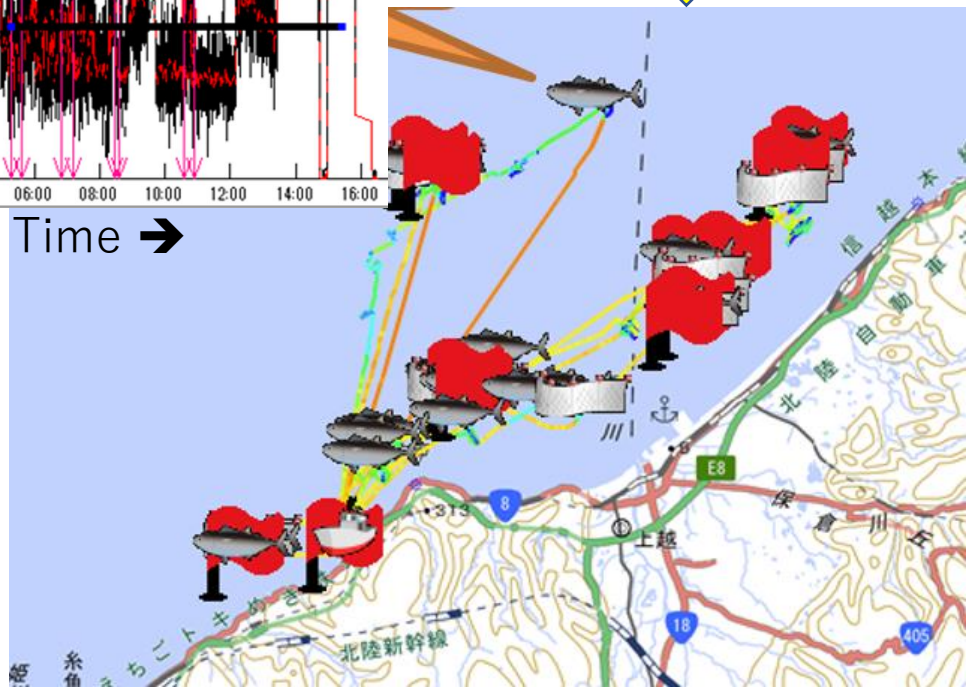
Users (Land)

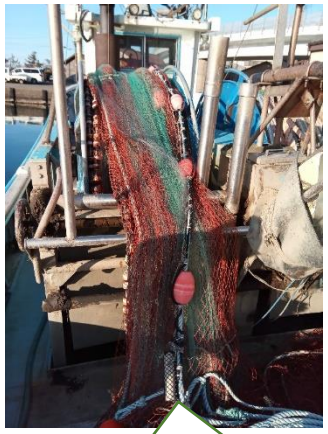
Catch
by spp. & set
(fishers)

Time series profile
Set-Haul, Catch
and Speed



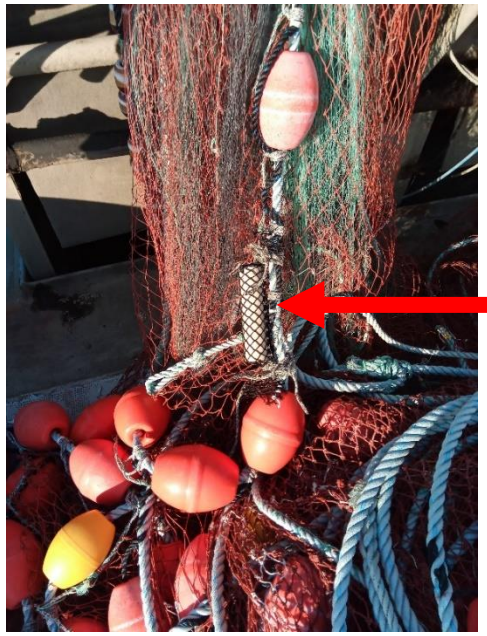
Mapping
Track lines and
Locations of
Set-Haul & Catch



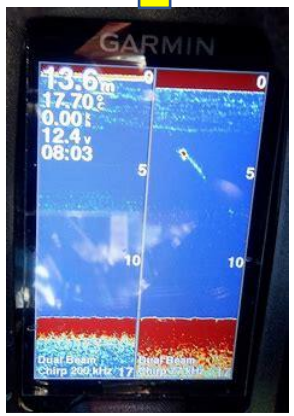


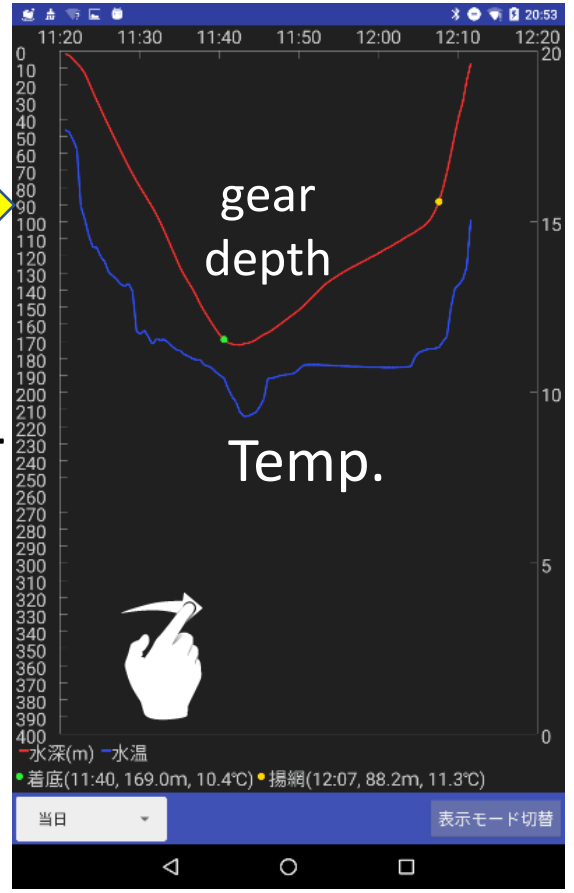
Data collection of 3-D gear locations, temp & depth using small wireless sensor attached to the gear.

Transmission of data to the GPS data logger
Profiling time series depth & temp (gear)



GPS data logger





Depth

Temp.

Time ➔

Wireless sensor

Echo sounder

Applications

GPS data logger

(1)
Real-time monitoring (fisheries info & sea conditions)

Cloud server (database)

(2) Good fishing grounds detected by the GPS data loggers from all vessels.
(more catch & less fuel costs)
➔ more profits

Application (accumulated data)

(3)**Fishers (profit)**
Pinpoint forecasting for good fishing grounds

(4) **Managers (conservation)**
(e.g. fine-scale closed areas and periods)

Users in land: Local
- fisheries cooperative
- fisheries research station

GPS data logger users (370) Japan


Troller (YFT, SKJ, neritic tuna)

Squid jigging boat


testing

ESL


Swordfish harpoon fishery

Pacific bluefin tuna recruitment monitoring **survey** (Fisheries Resources Institute)

Trawl, Purse seine, & Gillnet fisheries

2. GPS data logger: 2 additional systems

We are currently developing two additional AI based systems using Neural Network

- Fish species identification
- Fish size measurements

Contents

3. AI based fish species ID using Neural Network

How to do it?

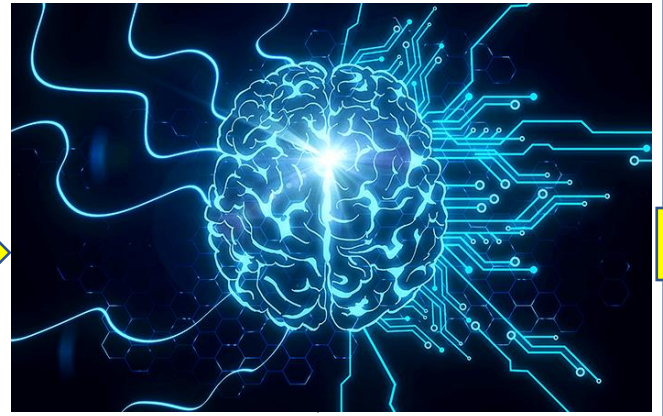
Species will be identified using images of catch picture
(including many species) taken by smartphones or tablets.

For identification,
AI (Neural Network) technology will be applied.

Steps : Species ID using AI (NN)

Learning data sets
> 1,000 images

NN learns images of species for ID



Repeat learning until reaching 90% classification accuracy

Application at site (Images from Tablet/Smartphone)

Species A (n=11)
Species B (n=18)
Species C (n=13)

3. AI based fish species ID using Neural Network

Preliminary trials

Results of preliminary trials suggest :

(1) can identify max. 80 fish species;

(2) can also identify fish species from parts of the fish body; and

(3) accuracy is subject to quantity of learning and quality of images

3. AI based fish species ID using Neural Network

Application for tuna

We are also planning to develop a tuna-specific model to identify between

juvenile yellowfin vs. bigeye tuna,

frigate vs. bullet tuna

billfish species from the body images (picture)

Contents

4. AI based fish size measurement with Neural Network

Fish size data is one of the most important information
(stock assessments & managements)

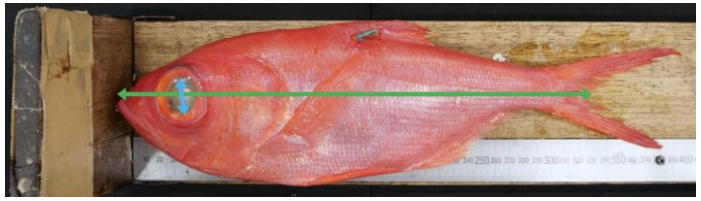
A few preliminary studies (including tuna) suggest:

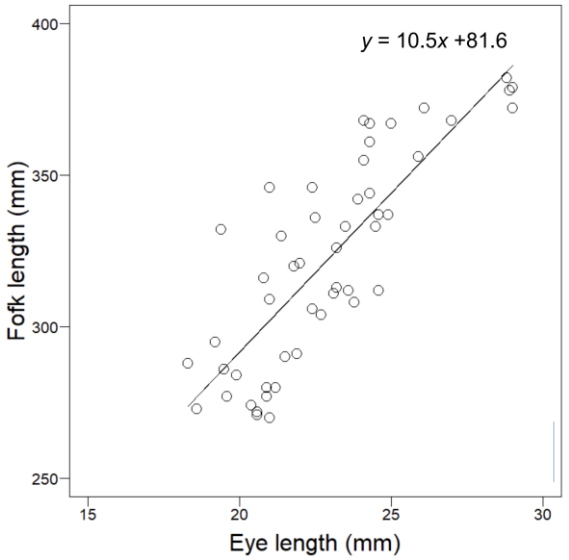
(1) Linear relationships
between eye size and fish size (fork length) by species
(but, various levels of correlations)

(2) **Eye size (image) is robust (accurate)**
Eye size (# of pixel) is not affected by any photo angles
(unlike longer objects such as fork length)

AI based fish size measurement with Neural Network: steps

(1) Estimate linear relation between eye size and fork length (SE, CV and r2)



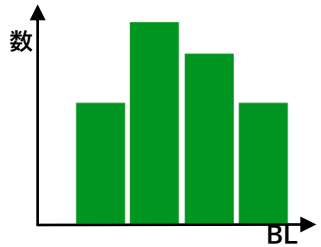


(2) Fish species ID by NN (classification error)

(3) Fish-eye extraction learning NN model (classification error)

(4) Measure Eye size (pixels)

(5) Estimate fish size using (1) linear relation



(6) How to use estimated size? (see next slide)

4. AI based fish size measurement with AI (NN)

Potential utilizations of estimated fish length by **level of accuracy**

Accuracy (direct measurement)			Classification errors (NN)	Possible utilization **(subject to users' criteria and decision)**
CV	SE	r2		
≈ 0%	≈ 0%	≈ 100%	≈ 0%	Stock assessments
Large	Large	Small	Large	Do not use
Small	Small	Large	Small	To learn approximate age/size compositions
				Stock assessments
(note) Values of small or large will be defined by users				

5. Goal: All 3 systems in one

Integrated data collection & transmission system
for fisheries related information & sea conditions

GPS Data logger (ICT) (at site)

ESL

(1) Fisheries info. &
sea conditions

Neural Network (AI)

MizLinx

(2) Species ID
(Catch image)

BOI

(3) Size
measurements
(Eye image)

Cloud
server
(database)

Feedback

Summary

- We presented our on-going works on 3 ICT or AI based data collection and transmission systems for fisheries related information & sea conditions (including species ID & size estimation) with mobile devices in Japan.

- Our final goal is to integrate all 3 systems in One GPS data logger for efficient, productive, reliable and low cost data collections to achieve sustainable fisheries and resources managements.

- At the landing sites, smartphone or tablet can be used independently (stand-alone) to collect fisheries related data (suitable for developing countries, e.g. IOTC).

References

- **Cheng**, B. (2021) Masked-attention Mask Transformer for Universal Image Segmentation. Facebook AI Research (FAIR). University of Illinois at Urbana-Champaign (UIUC).

- **Christopher**, R. *et al* (2020) Body size determines eyespot size and presence in coral reef fishes, Ecology and Evolution.

- **Garcia-d'Urso**, N. *et al* (2022) The DeepFish computer vision dataset for fish instance segmentation, classification, and size estimation. Scientific Data 9(287).

- **Haynes,** S. and **Fritsches**, K. (2022) Fish Eyes More than Meets. Evaluate fish physiology and ecology using vision research data. Bridge Ocean Science Education Resource Center, Sea Grant Office (USA).

- **Schmitz**, L. and **Wainwright**, P.C. (2011) Nocturnality constrains morphological and functional diversity in the eyes of reef fishes. BioMed Central (BMC). Evolutionary Biology 2011, 11:338

Acknowledgements

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to arrange for us to present our works.

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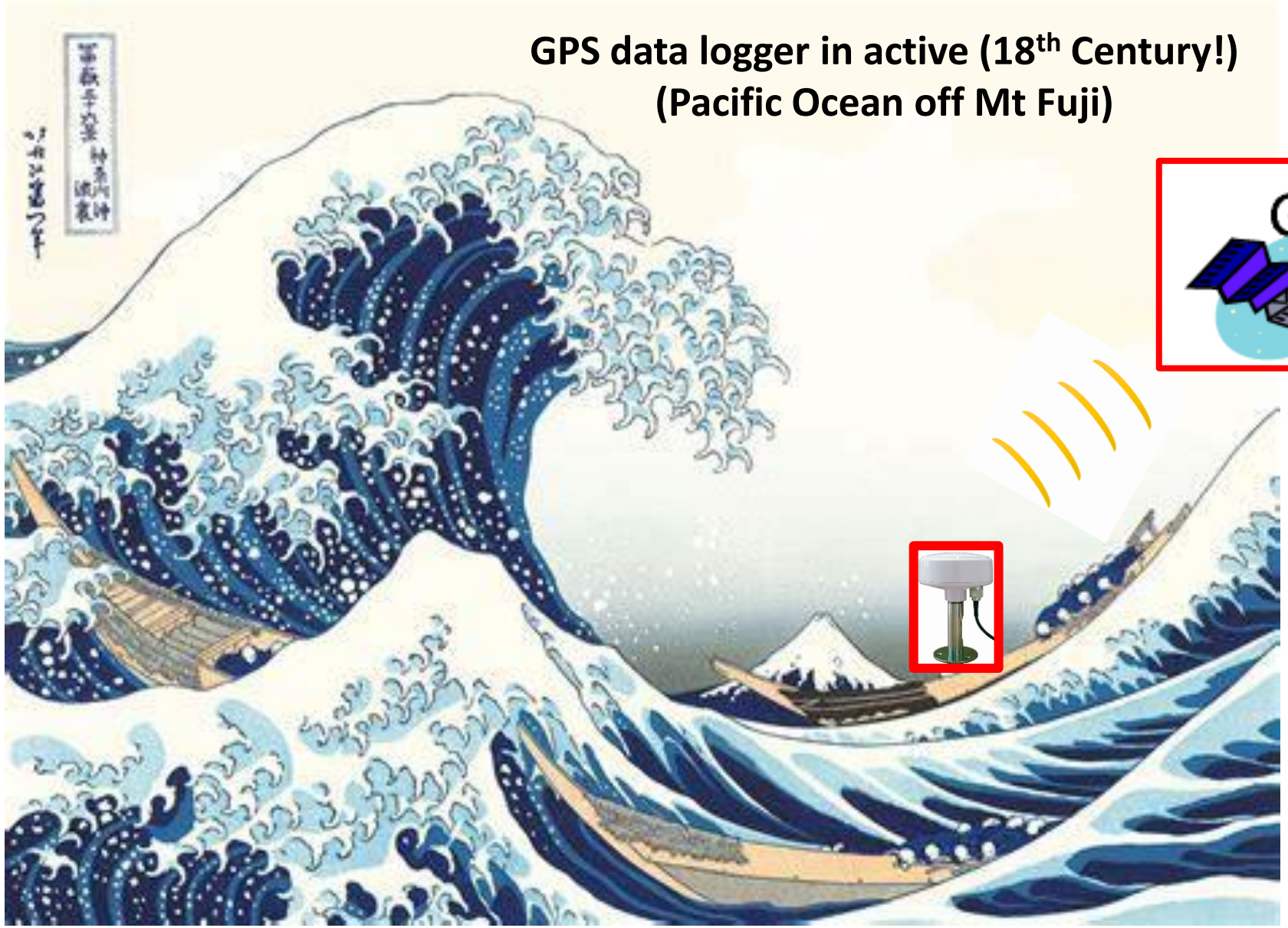

Abstract (1/4)

We have been developing three different types of ICT or AI based data collection and transmission systems for fisheries related information & sea conditions using mobile devices. The outline of three systems are described as below:

(1) GPS data logger

The GPS data logger is the real-time data collection and transmission system for fisheries related information and sea conditions using a tablet connected to GPS, sensor and echo sounder on small coastal fishing vessels and has the following five functions: (i) to collect exact vessel track lines every second, (ii) to collect & enter catch by species for each set by fishers, (iii) to collect 3-D gear locations and sea temperature by small wireless sensors attached to the gears and also to collect the bottom depth data from the echo sounder, (iv) to transmit these data to the GPS data logger to produce automatic display of depth and sea temperature profiles for each set, and (v) to transmit all data to the cloud server and update the database for users to utilize.

Abstract (2/4)

The collected information can be used to implement the following four important tasks: (i) real-time monitoring of fisheries related information and sea conditions, (ii) quick identification of good fishing grounds by sharing data from all vessels using GPS data loggers for higher catch and lower fuel costs (to get more profits), (iii) pinpoint forecasting for good fishing grounds using accumulated information, and (iv) reliable resource managements (e.g., to establish fine scale closed areas and periods).

Our GPS data loggers are currently used by 370 boats with different types of gears including tuna troll fisheries (yellowfin, skipjack, and neritic tuna), hand harpoon swordfish fisheries, trawl, purse seine, gillnet and squid fisheries. In the research area, our GPS data logger is utilized by Pacific bluefin tuna recruitment monitoring survey. At landing sites, our system is used also with smartphones (no GPS).

We are currently developing two additional AI based systems, i.e., fish species identification and fish size measurements using Neural Network (NN) which outlines are described as follows:

Abstract (3/4)

(2) Fish species identification by NN

We apply AI (Neural Network) to identify fish species using images of catch picture (including many species) taken by smartphones or tablets. Results of our preliminary trials based on NN learnings suggest, (i) max. 80 fish species can be identified, (ii) species can be also identified from parts of the fish body, and (iii) accuracy is subject to quantity of learning and quality of images. We are also planning to develop a tuna-specific model to identify between juvenile yellowfin vs. bigeye tuna, frigate vs. bullet tuna, and billfish species from the body picture (images).

(3) Fish size estimation by NN

A few preliminary studies (including tuna) suggest (i) there are linear relationships between eye size and fish body size with various levels of correlations by species, and (ii) eye size from the image is robust (accurate) to measure as it is not affected by photo angles unlike the longer object (e.g. fork length).

Abstract (4/4)

Based on two suggestions, we are currently developing a system to estimate fish size from eye size using five steps : (i) to estimate relations between fish eye vs. body size (fork length) by real measurements, (ii) to identify species from image (catch photo) by NN as explained previously, (iii) to let NN to learn locations of eyes from images of the fish, (iv) to measure eye size (pixel) in the image of the fish, (v) to estimate fish size using the linear relation. SE, CV & r2 (in the linear relation) and classification errors (NN) will be provided for users to understand levels of uncertainties.

Our goal

Based on three systems outlined above, our final goal is to build an integrated system by combining all of three into one GPS data logger. With this integrated system, we can (i) collect fisheries related and sea condition information, (ii) identify species from images of multiple fish species pictures taken by tablet or smartphone and (iii) to estimate fish size by measuring the eye size from eye images of fish identified and by substituting it to pre-learnt relation between fish eye and size.