Fish Species Annotation System for Environmental Detection by Marine Life as a Sensor

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Abstract
The ocean was born on the earth 4.6 billion years ago. Life was born in the ocean, further evolved creatures created oxygen in the ocean, and that oxygen also changed the atmospheric composition of the Earth. From ancient times life has received many benefits from the ocean. Even in recent years, fluctuations in the marine environment are drawing attention as one of the major environmental problems. Because there is a possibility that it will have a big influence on human society and ecosystem. Therefore, in the field of oceanography, research to detect and predict changes in the marine environment in various ways is actively conducted. We aim to detect changes in the marine environment from the behavior of marine organisms (mainly fish). In this paper, we implemented a system for annotation of fish species which is an important module for our research. This system aims to collect accurate data on fish species by targeting professional oceanographers. For motivation for annotation work, the system provides analytical results and generation models as rewards for work. We also conducted a questionnaire survey of 14 professors, researchers, and students specializing in oceanography for annotation system.

Author Keywords
Ocean; Oceanography; Annotation system; Movie processing

ACM Classification Keywords
H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous

Introduction
Changes in the marine environment are drawing attention as one of the major environmental problems. Marine environmental changes can have great influence on human society and ecosystems. For example, ocean acidification inhibits the synthesis of calcium carbonate (CaCO3), which is the bone and exoskeleton of marine organisms, and adversely affects ecosystems[7]. Especially the lack of skeleton components of coral will greatly affect the coastline because it will impair the wave-extinguishing effect of the coral reef. The marine environment changes will also affect human society and human health through food. According to Food and Agriculture Organization[3], consumption of fish per capita in the world exceeds 20 kg. This value corresponds to 6.7% of the total consumed protein. The disorder of sea ecosystems and pollution of seafood are deeply related to human beings.

Marine environment is affected by complex factors such as water temperature rise due to global warming, poor oxygenation and decrease in pH due to increased carbon dioxide. Research to detect and predict changes of the marine environment in various ways has been proactively conducted in the field of oceanography. We aim to detect changes in the marine environment from behavior of marine organisms (mainly fish). In this paper, we describe an annotation system of fish species, which is an important module of this research.

Related work
Various research tackle to detect marine environment change in oceanography. As common measuring method, many research institutes measure marine environment from the ocean's water temperature, salt concentration and pH. Furthermore, research to measure trace molecules in the ocean[2, 6] and detection of oil film on the water surface[5] are also being conducted. On the other hand, we proposed a system that detects the state of ornamental fish in aquarium from fish motion as a past study[4]. A system named "TalkingNemo" tracks ornamental fish by using image analysis technology from the camera installed on the front of the aquarium, and classifies the state of the fish into several different classes, such as calm, active, fear and eating based on their physical movement. We thought that we can use the method used in this research for the detection of marine environment.

Goal of the study
In this paper, we propose a method is to detect the marine environment from the distribution and behavior of marine organisms using camera images in the ocean. As a hypothesis of this research, we believe there is a close relationship between the marine environment and the behavior of marine organisms. Additionaly, some organisms have a keen sense than humans and sensors. By using these organisms as sensors, we will be able to obtain more versatile and detailed data. In addition, the marine environment consists of various parameters intertwined. Therefore, we think that biological data with high degree of abstraction is greatly affected by the environment. The behavior recognition method of fish used in previous research will be useful for environmental detection by marine organisms as a sensor.

The mainstream of marine organisms research methods is to attach tags to organisms. This method is very stressful to marine organisms because it is necessary to capture them and attach tags directly to their body. In addition, in

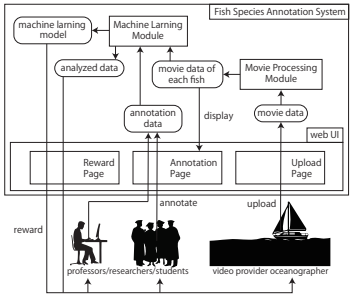

Figure 1: System Overview

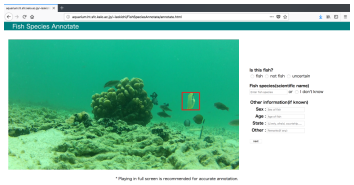

Figure 2: Screenshot of Annotation Page

research to observe organisms in the sea, it is mainstream that researchers themselves observe organisms from images. We aim to automatically detect marine organisms using Information and Communications Technology (ICT)-based solutions here. Therefore, annotation data for constructing a machine learning model is required.

Challenges in advancing research

As mentioned in the previous chapter, a major problem is that accurate annotation data of fish is required. In order to gather many annotation data, there is a method using crowdsourcing such as Amazon Mechanical Tark[1]. However, it is difficult to collect professional data because crowdsourcing is for performing simple tasks. Since the necessary annotation data requires accurate and specialized knowledge, data collection using crowdsourcing is not suitable.

Therefore, in this paper, we propose a system for collecting annotation data of marine organism type for specialists with expert knowledge.

Solution

In this paper, we propose a fish species annotation system for experts. We are aiming at professors, researchers and students in the field of oceanography, and staff of aquarium and aquaculture industry as subjects.

Generally, annotation work such as crowdsourcing often pays money as a reward. Instead, in this system we provide analyzed fish species data and created machine learning model. as consideration according to the amount of work. This allows experts to avoid wasting precious time. And, it motivates annotations by providing useful data for experts.

System architecture

We implemented a system for annotation on the web. The user create an account and then they can post movie data and do annotate work.

Figure1 illustrates an overview of this system. The system detects marine organisms from posted movie using background subtraction and tracking. Next, the system cuts out the original movie into a short movie until one marine organisms comes out in the movie and disappears. The marine organism is surrounded by a red frame, and the user labels information such as fish species. The user can input sex and age for information other than fish type. This is because some fish seem to have a big difference in appearance during sex and growth process.

Evaluation

In order to investigate the usefulness of this annotation system, we conducted questionnaires for professors, researchers and students specializing in oceanography. In the questionnaire survey, we presented a system overview and mockup. Also, we explained that analytical data is provided as a reward.

We obtain answers from 14 people. Our results are shown in Table1.

From this result, it turns out that most researchers will be able to annotate fish species. It should be noted, those who showed negative responses to annotations of fish species were researchers dealing with large animals such as sharks and whales. Regarding other information, we got an opinion that “only some fish species have sexual dimorphism/dichromatism” and “if there was an estimate of fish length, then we could estimate the age of the fish from a growth model”. We think that annotation is possible if those information appear greatly in appearance. It seems that

Table 1: Questionnaire Results

Question	1 (Strongly disagree)	2	3	4	5 (Strongly agree)
Did you clearly understand which fish you should be labeling ?	0	0	0	1	13
Are you confident about using this annotation system to label fish species?	1	1	2	5	5
Are you confident about using this annotation system to label other information on fish?	4	3	7	0	0
Do you feel awkward for video you uploaded to be seen by other researchers?	1	1	6	4	2
Do you feel awkward for other researchers use the AI that you labeled?	0	2	6	3	3
If AI that automatically identifies species of fish is provided as a reward, do you think that AI will be useful for your research and projects?	0	2	2	4	6
Do you want to use this system when it is released?	0	0	1	6	7

there is not much awkward to movies and work results being used by other researchers. Also, many respondents said they wanted to use this system or could use it for their research and projects. From this, it can be said that the system is highly useful. However, there are many opinions that answer of free description requires accuracy of 90% or more is necessary. This is a future development issue.

Summary

In this paper, we explained the fish species annotation system for environmental detection by marine life as a sensor. This system aims to collect accurate data on fish species by targeting professional oceanographers. For motivation for annotation work, the system provides analytical results and generation models as rewards for work. We conducted a questionnaire survey on the system for 14 oceanographers. As a result, it was found that many oceanographers can perform annotation work of fish species, and that rewards can motivate oceanographers to do work. It can be said that this system is useful for research on oceanography.

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