Application of ultrasonic telemetry system for monitoring depth of trolling gear

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Abstract

Cutlass fish (Trichiurus lepturus) is fished with trolling in the west of Japan. In that fishing, because the trolling depth affects the catch, the fishing gear has to be positioned at the depth of fish school accurately. Normally, fishermen estimate the gear depth from the length of reeling the sinker from the bottom by a spool. However, if the sea state gets worse and/or if the fishing is operated in a deeper fishing place, it becomes difficult to make the adjustment of the gear depth and fatiguing the fishermen. In order to reduce the workload and make it easy to adjust the gear depth, we applied ultrasonic telemetry system to the trolling gear as a system for monitoring depth in real-time. The system is consisted of a pinger and a receiving system with an omni-directional wired hydrophone and a display of the pinger's depth. The pinger's battery is easily-exchangeable to use it repetitively. The system was tested by experiments in actual fishing operations and could show the gear depth every few seconds. Therefore, without letting the sinker touch the bottom, it is possible to obtain the accurate gear depth. In addition, it was possible to easily handle the system by fishermen themselves. From this study, it is expected that our system can reduce the workload.

Keywords: *ultrasonic telemetry, fishing gear, depth measurement, cutlass fish*

Introduction

Information of underwater position of fishing gear in operation is useful to improve work efficiency. Thus, there have been some acoustic systems for monitoring fishing gear in real-time [1]. However, these systems are too large and heavy to equip for small fishery boats. On the other hand, ultrasonic telemetry systems using small transmitters called "pinger" have the advantages that it can obtain real-time data and the system is very small. This study shows an example of application an ultrasonic telemetry system for monitoring a fishing gear operated by small fishery boat.

The target of this study is a trolling gear catching cutlass fish (*Trichiurus lepturus*). This fishery has operated in western Japan. In the fishing, because the trolling depth affects the catch, the trolling gear has to be positioned at the depth of fish school accurately. But it is difficult for fishermen to know the exact depth of the gear directly. Then, they estimate the gear depth from comparing water depth measured by an echo sounder to the length of reeling the sinker from the bottom by a spool. However, this work requires years of experience. In addition, if the sea state gets worse and/or if the fishing operated in a deeper fishing location, it becomes difficult to make the adjustment of the gear depth and fatiguing the fishermen. If the gear depth in operation can be measured, it is possible to reduce the workload and for less-experienced fishermen to adjust the gear depth accurately. In order to achieve it, we applied ultrasonic telemetry system for monitoring the depth of gear in real-time.

Material and Methods

System construction

The monitoring system was based on an ultrasonic biotelemetry system using PN (pseudo noise) sequence signal [2, 3]. In order to improve the signal to noise ratio and to extend the range of the propagation, this system can send 32 kinds of PN sequence codes and the receiver correlates the signal by correlation (pulse compression) [3].

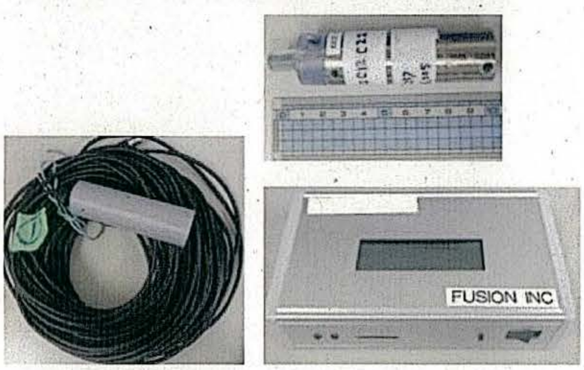

Fig. 1: Pinger, hydrophone and receiver

Generally, pingers attached to animals can be used only once because the pingers equipped targets are not assumed to be collected. By contrast, if the pinger is put on a fishing gear, the pinger can be picked up and used it respectively. Then, we used the pinger (FRTD-600A, FUSION Inc.), which could exchange the battery easily. The size of the pinger is 24 mm diameter and 100 mm length. The pinger has a depth sensor and transmits the depth data. When the pinger sends a signal, two pulses are transmitted and the interval of two pulses is changed corresponding to the pinger's depth. The receiving system measures the interval and calculates the depth. The depth resolution is about 0.1 m (if the range is 250 m).

The receiving system consisted of an omni-directional hydrophone and a receiver that identifies the pinger's IDs and displays the depth of the pingers (Fig. 1). The size of the receiver is 170 mm×100 mm×40 mm.

Testing the system

To test the efficacy of the prototype system, we equipped a fishery boat with the system and conducted two experiments. The site of that was the offshore of Kunisaki peninsula, Oita prefecture, Japan. Firstly, we measured the accuracy of the depth data of the system on May 17, 2013. The pinger (the range of the deapth was 50 m.) and a depth data logger (MDS-MKV, JFE Advantech Co., Ltd., the range is 50 m, the resolution is 0.1 m) were tied up on 2 m upper side of the sinker. Then, the same way as the actual operation, the fishing gear was operated at an about 50 m water depth area. The system and the logger recorded the gear depth. The recorded data were compared to evaluate accuracy of the depth data measured by the system. Secondly, we let the fisherman use the system in actual operation (we didn't board his boat). The experiments conducted on November 21, 2013. The water depth of fishing location was about 200 m. The pinger (the range of the depth was 20m) was installed at the same point as the first experiment. The receiver was deployed in the cabin to make possible for him to look the display of the receiver and the echo sounder at the same time. The hydrophone was towed behind ship on depressor at predetermined depth. Track of the ship was recorded by a GPS logger (M-241, Holux). After the operation was finished, we got feedback from the fisherman.

Results

Accuracy of the depth data

We could monitor the depth of the pinger during the operation every few seconds. Compared to the logger data, the measured data by the system differed within 1 m and the relative vertical movements corresponded (Fig. 2). Black circles shows that the fisherman adjusted the depth of the gear and the depth was once deeper. Since fish school observed by echo sounder in the time shown by a green circle, the depth of the gear was adjusted the same depth as the fish school. The time from 7 minutes to 13 minutes, the pinger depth was invariable because the pinger's depth sensor became saturated.

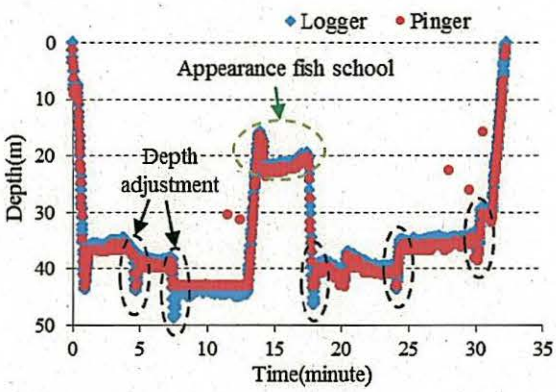

Fig.2: The depth data measured by the monitoring system and by the depth data logger.

Testing in the actual operation

The trolling was operated ten times. Although the gear was at a depth of about 200 m, continuous depth data could be measured (Fig. 3). But there were some data having large deviations from the continuous data. Then, the rate of this error data was calculated. In the result, the average of the rate was 4.7 % and the range of that was from 0.7 % to 13.3 % (Table 1). The error rate had no correlation with the depth of trolling.

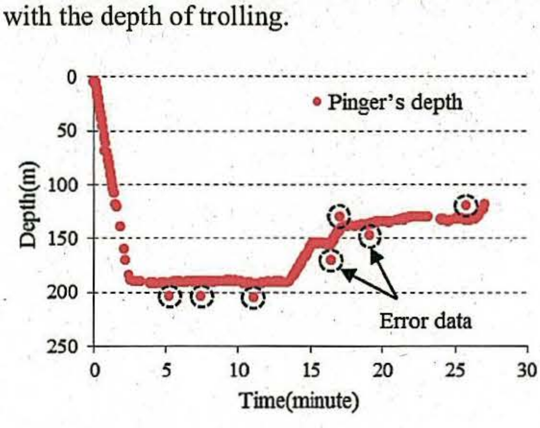

Fig.3: An example of the pinger's depth measured by the monitoring system in actual operation.

The fisherman said that if the system was used, he didn't have to be nervous to adjust the gear depth with thought to estimate the sea condition (e.g. tidal current). In addition, the estimated depth by fisherman was different to monitored depth in a certain situation.

Table1: Summary of the all trolling operated on November 21, 2013. It shows the trolling time, the number of the total depth data, the number of the error depth data, the error rate and the range of the gear depth of trolling.

Trolling No.	Trolling time (min)	Total data number	Error data number	Error rate (%)	Gear depth range (m)
No.1	29	459	3	0.7	120~200
No.2	27	373	7	1.9	120~200
No.3	28	241	7	2.9	120~140
No.4	26	375	24	6.4	110~140
No.5	30	240	32	13.3	90~140
No.6	20	236	9	3.8	80~110
No.7	33	410	16	3.9	110~140
No.8	24	306	10	3.3	110~140
No.9	33	347	20	5.8	100~140
No.10	25	138	9	5.1	120~190

Discussion

The experiments found that accurate continuous depth data of the fishing gear were measured and watched in real-time on a boat. The results show that wasted motion of the gear able to be reduced and it becomes easy to adjust the gear depth accurately. However, the some error data were observed. While the cause was expected that one of the two pulses transmitted by a pinger reflected off the sea bottom, the evidence wasn't found in the results. Therefore, it is necessary to compare with the gear depth and water depth to discuss the condition in which the error data increase.

The opinion of the fisherman showed that the system could contribute to improve safety in the operation because the system reduced nerve to handle the fishing gear and the fisherman could focus on ship handling instead. Then, it was thought that the system enabled fishermen to adjust the gear depth easily and accurately without relation to sea condition. Especially, the merit is useful for less-experienced one.

Conclusions

This study showed an example of application an ultrasonic telemetry using pinger to small fishery boat as a monitoring system of a fishing gear and the system could measure continuous vertical motion of the gear in real-time. Installation such a system serves useful information for fishermen in operation.

References

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