A Study on the Telemetric Measuring System of the Underwater Information

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This Paper describes technique for the design of system for telemetering the water temperature at sea. This telemetering device adopts FM-FM system, and its main carrier wave is 146.2 *MHz*. The transmission power is about 1*W*, and the available distance of transmission is 2*km*.

The telemetering time for the transmission and pause is controlled automatically by the CMOS programmable timer. The water temperature is measured by the electronic thermometer, it is varied by V-F converter which is built to a linear voltage controlled oscillator.

The results of the experiment at the place where the receiver is off 2*km* from the transmitter, the water temperature measured with the mercury thermometer well agree with that of the telemetring device.

Introduction

The observation of the environmental factors in the fishing ground is useful to be study the behaviour of free-swmming fish and the position of fishing ground.

For the observation of the environmental factors in fishing ground, usually, the ship has been used directly to observe. The method by the ship has been a serious limitation, discontinuous, uneconomical and it is followed a possibility of danger.

Recenly, the telemetry systems to study the behaviour of fish and the environmental factors of its surrounding water have been considerably developed, and there are a number of studies for those ones.

Kuroki et al. (1971) have been carried out which make use of a new telemetric apparatus to detect fish location and its surrounding water temperature. A more complex type of device, the transponder has been developed by Mition et al. (1971). Luke et al. (1973) has been developed a small transmitter for tracking aquatic animals. Hawkins et al. (1974) has been used to follow the movements of tracking cod *Gadas morhua L.* in a Scottich sea beach. Konagaya(1980) has been described a trial method to telemetry of the setnet fishing ground.

The limited field estimates of locometer energetics have been attempted using position fishing techniques in conjunction with ultrasonic pinger tags(Young et al., 1972; Holliday et al., 1974;Tytler et al., 1978; Hawkins et al., 1974).

An ultrasonic biotelemetry system for the continuous monitoring of tail-baet rate from free-swimming fish; An 8-channel, ultrasonic, marine biotelemetry transmitter utiling CMOS digital intergrated circuits; Determination of the swimming depth of fishes during the hours of daylight; An ultrasonic device in biotelemetry and its application to tracking a gellowtail; development of a multichannel, ultrasonic telemetry system for the study of shark behaviour at sea have been described by Rose et al. (1981), Ferrel(1972), Gayduk et al. (1971), Ichihara et al. (1972), Standora et al.

(1972), respectively. The investigation using telemetry system can contribute a great deal of the population study by increasing the number of individuals to be observed.

On the other hand, in Korea, telemetring of the underwater noise has been described by Shin et al. (1987), but knowledge of the telemetry system of the environmental factors at sea is poor and the environmental factors has largely been measured directly by use of ship.

In this paper, systems in these areas is discussed. As it can be seen the emphasis is on the telemetic measuring system of the underwater information because this has been the most urgent requirement for the development of the fisheries resource in Korea.

Materials and Methods

1. Telemtry of parameters

The present research system is divided into the telemetry transmitting control and the water temperature receiving control system, which is shown in Fig. 1.

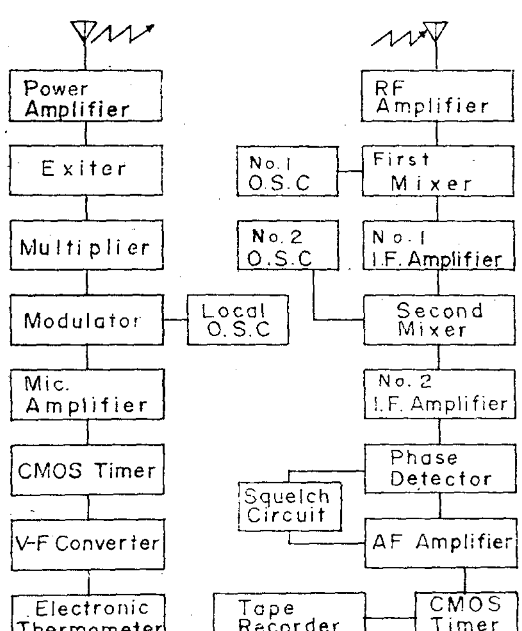

Fig. 1. Block diagram of the telemetry system.

These system consist of a transmitter, a receiver, a time controller, and a recoding apparatus.

The telemetry transmitting control system is an activity observing system, which can transmit water temperature signal observed by electronic thermometer. The water temperature receiving control system is a temperature observing system, that can find the environmental temperature in the fishing ground.

2. Transmitter

The transmitter consists of CMOS timer, electronic thermometer, V-F converter, mic-amplifier, modulator, multiplier, exiter, power amplifier and antenna.

when the electronic thermometer is operating, its temperature signal is fed to a three stages mic-amplifier, and then the amplited signal is varied by FM modulation.

The FM output of the phase modulator is fed through three frequency doubler stages multipliers, the output of which is fed through the exiter to a power amplifier. Its output is tuned broadly within 146 *MHz* to 147*MHz* range and is transformer coupled to antenna system.

3. Receiver

The incoming 146.2*MHz* signal from the receiving antenna system is fed to one-stage of RF amplifier, the output of which also fed to a first mixer.

The 146.2 *MHz* FM signal and an unmodulated local oscillator signal are both fed into the first mixer with the FM output signal at a frequency equal to the difference of two signal fed to the first mixer. when the local oscillator operates at 156.9 *MHz*, the first mixer output can be at 10.7 *MHz*.

The 10.7 *MHz* signal is known at the intermediate frequency (IF) signal, which is amplified to the IF amplifier. This signal is fed to a second mixer, which is also fed an unmodulated oscillator operates at 10.245*MHz*, the resulting second IF signal can be at 455 *KHz*.

This 455 *KHz* output signal of the second mixer is fed through a selectivity filter to a two-stage 455 *KHz* IF amplifier, which in turn feeds an amplifier limitter, the output of which is fed to a gated beam phase detector.

The AF output of a gated beam phase detector is fed to a two-stage AF amplifier. The noise component at the output of a gated beam phase detector is fed to a squelch circuit, consisting of the squelch amplifier, a voltage doubler, and a recifier, which is fed to a tape recorder. The water temperature is recorded on the tape recorder.

4. Telemetry timer

The telemetry timer is used to the CMOS programmable timer (MC 14536B, MOTOLORA), which is a flexible 24-stage ripple code. Provisions for an on chip RC oscillator or an external clock are provided.

An on-chip monostable circuit incorporating puke-type output has also been included. By selecting the appropriate output in conjunction with the correct input frequency, a variety of timing can be achieved.

A pair of this programmable timer is connected to the tape-recorder and the transmitter respectively, which is used to control the transmission and the pause time.

The tape-recorder and the transmitter timer set to operate simultanously, the transmission and the pause time of which set to operate 8 seconds, 8.5 minutes respectively.

5. Water temprature sensing thermometer

The water temperature sensing thermometer (2-K, MURAYAMADENKI) is constructed with a wheatstone bridge circuit, a dial of the temperature and the thermistor probe.

The resistance of a wheatstone bridge circuit is proportional to the temperature. It is built a circuit that can accurately the resistence of the thermistor and is calibrated the dial in terms of temperature.

The output of the thermometer is varied V-F converter which is built to a linear voltage controlled oscillator, and then its signal is fed to the input terminal of the transmitter.

6. Recording and analizing system for the telemetered data

When the transmitter is operating, its temperature signal sends to receiver.

The transmitting response of the electronic thermometer is revealed as a function of frequency, which is recorded by the tape recorder (TC-60A, SONY). The output of the tape recorder is fed to a frequency analyzer (B&K, 2131), and the mean frequency for the water tempeature is measured in the receiving time sequence.

The measured frequency is changed to the water temperature, it is investigated to compare with the mercury thermometer temperature which is measured directly at the transmitting site.

Results and Discussion

The relationship between the input voltage which the sensed temperature signal by the electronic thermometer is used to convert through the V-F converter to the frequency and the output of frequency is shown in Fig. 2.

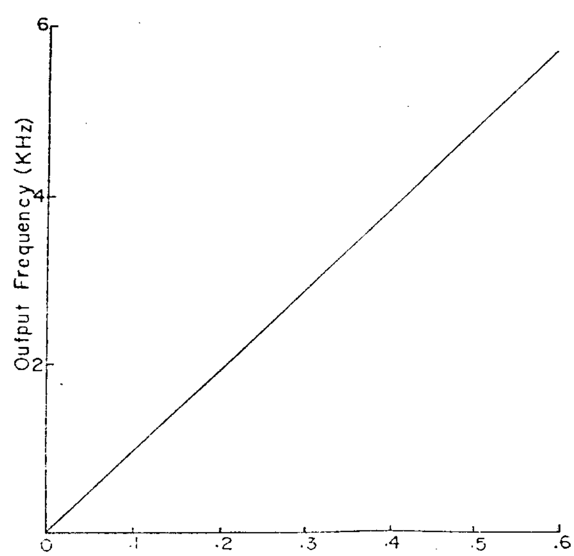

Fig. 2. The relationship between the input voltage and the output frequency in the V-F converter.

The input voltage(E) and the output frequency (F) illustrated in Fig. 2 shows that the output frequency becomes increaser in proportion to the input voltage, which the regression equation is $F=9.5E$. In case of the experimeted V-F converter, the input voltage is available within $5\,mV$–$100\,mV$.

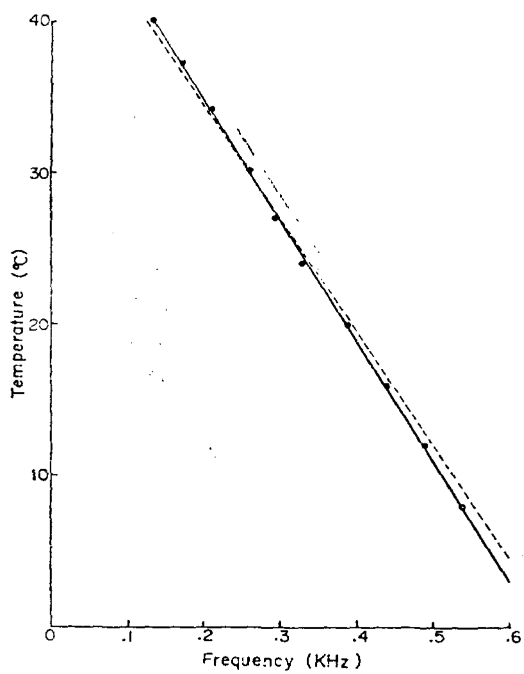

Fig. 3. The relationship between the frequency and the temperature in the experimented telemetry system.
solid line: the observed values at the transmitting site
dotted line: the observed values by the telemetry system at the receiving site
● : the direct observed values by the mercury thermometer.

Fig. 3 shows the relationship between the frequency(F) and the water temperature(T) at the transmitter site, of which the regression equation is $T=-75.5F+50$ as illustrated solid line. It is clearly recognized that the water temperature becomes to decreaser when frequency is higher, and it is agreed with the observed values by the mercury thermometer.

In the other hand, the results of the observed values by the receiver of the telemetry system is the same as transmitter site, its regression equation can express $T=-73.4F+49$ as illustrated dottedline in Fig. 3.

The comparison results of the observed values by the mercury thermometer and the telemetry in Fig. 3 is made a positive regression (correlation coefficient is 0.87) within $5°C-40°C$ and a perfect positive regression (correlation coefficient is 1) within $12°C-37°C$.

Consquently, it is confirmed that this telemetry system for the water temperature is possible to observe availably within $12°C-37°C$.

Conclusion

A systematic approach to the design of the water temperature telemetry systems has been described.

Although the motivation for most of this work has been for the water temperature observing applications, the results are applicable to the fish tracking applications and to a wide range of underwater information telemetry problems.

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水中情報의 遠隔計測시스템에 관한 研究

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(1988년 2월5일 접수)

水産, 海洋資源을 개발함에 있어 가장 중요한 요소중의 하나인 海洋環境要素를 효과적으로 측정하기 위해 遠隔制御裝置를 제작하여 水溫에 대한 遠隔制御實驗을 행한 결과, 水銀溫度計로 직접 측정한 측정치와 遠隔制御시스템에 의한 측정치는 水溫 12°C~37°C 범위에서는 完全正相關을 이루어, 본 遠隔計測시스템은 水溫의 遠隔制御에 효과적으로 활용할 수 있음을 확인할 수 있으며, 다른 水中情報의 遠隔制御에도 크게 활용될 수 있으리라 생각된다.