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AUTOMATIC RECORDING OF FISH HEART RATE ON A PERSONAL COMPUTER

by

Svein Floen, Bjørn Totland og Jan Tore Øvredal
Institute of Fishery Technology Research
P.O.Box 1964 Nordnes, 5024 Bergen, Norway

ABSTRACT

From acoustic tags operated into fish in a closed system, the heartbeat signals are sent via underwater telemetry and counted on a personal computer. The computer removes false pulses caused by noise, and calculates the heart rate for one minute based on reliable heartbeats. Up to 6 fish can be monitored in a sequence of one minute per fish. The heart rate is stored on a file, or transferred to another computer.

BACKGROUND

There is little information about the behaviour of salmon in marine net pens (Bjordal et. al. 1986). Some measure of the activity level and response to stressors is urgently needed, and the heart beat rate of the fish could be important in this connection. Marked variations in pulse rate have been observed, i.e. in connection with feeding, de-lousing and disturbances (Bjordal et. al. 1988).

Acoustic tags and receivers for detection of the ECG-signal, have been developed (Holand, 1983). Previously the equipment was used by listening to the loadspeaker of the receiver and tuning it manually to the carrier frequency of each tag. On the basis of this equipment, we have developed hardware and software for automatic registration of the heart beat frequency of several fish.

SYSTEM DESCRIPTION

The system consists of the following units (Fig.1).

Heart tag

The tags are operated into the body cavity of the fish. As the heart beats, it generates a voltage potential, which is transmitted as a frequency modulated acoustic signal (Holand, 1983).

Hydrophone with receiver

A hydrophone detects the signal from the heart tags. The receiver filters and amplifies the signal, and transforms it to an audible frequency. Several tags can be monitored by adjusting the filter to the carrier frequency of the tags (Mohus and Holand, 1983).

Signal converter

This unit converts the frequency modulated signal to ECG-signals (Mohus and Holand, 1983).

Multiplexer

In order to choose between several heart tags, the multiplexer is controlled by a microcomputer (Fig. 2). One potentiometer for each channel (1-6) is adjusted to decide witch frequency the receiver will detect. The pulses from the signal converter are made longer to suppress noise.

Micro- and minicomputer

A microcomputer is programmed to read the heart pulses from the multiplexer via a standard parallell port. Selection of multiplexer channel is controlled via the same port. The program calculates the time lap between each hearbeat with an accuracy of 1/100 second. The channels are read in sequence with one minute per channel.

Due to signal noise the pulsrate may contain false pulses, or pulses may be lost. The program compensates for this by filtering the measured time lap between pulses within specific limits, based on previous heartbeats. Time laps shorter or longer than the limits are rejected. The pulsrate of one minute is calculated on basis of the number of accepted heartbeats and the ellapsed time. If the number of rejected heatbeats is more than a certain limit, the pulsrate of this period is not accepted.

After calculating the frequency of the heartbeats, the results are transferred to a minicomputer (HP1000) and written into a database which is part of a major control- and monitoring system.

EXPERIENCES

By using a microcomputer for automatic registration of heartbeats, better utilization of the original system is obtained. While one person previously had to register the heartbeats of the fish manually and for a limited time, the monitoring is now done continously and automatically. Further analysis is simplified by storing the pulsrate with other measurements integrated in a data base.

The following factors have proved to influence the results:

- Positioning of the electrode inside the fish

  The positive electrode must be placed in the pericardium, while the negative is attached to the body cavity. Weak signals or signals from other muscles may be the result of misplacing the electrodes.

- Hydrophone position

  Distance from the fish should vary as little as possible to avoid shifting av the carrier frequency (Dopplereffect) due to rapid fish movement. To reduce reflection from the bottom and surface, directional hydrophones are recommended.

- Tuning of signal converter and multiplexer

  For each channel the multiplexer must be tuned to an output signal from the receiver of 1 kHz, followed by tuning of the signal converter accordingly. More accurate tuning is described in the user manual (Mohus & Holand,1983).

- Change in temperature

  Sea temperature influences the carrier frequency. Tags compensating for this are now available. The system becomes more stabil and reliable, and reduces the need for recalibration.

Noice and unregistered heartbeats are the results of these factors. The multiplexer and the microcomputer program give a way to reduce these errors and monitor the heartbeat automatically.

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Holand, B. 1983. Fish Telemetry, 1982. SINTEF-report Jan. 1983.

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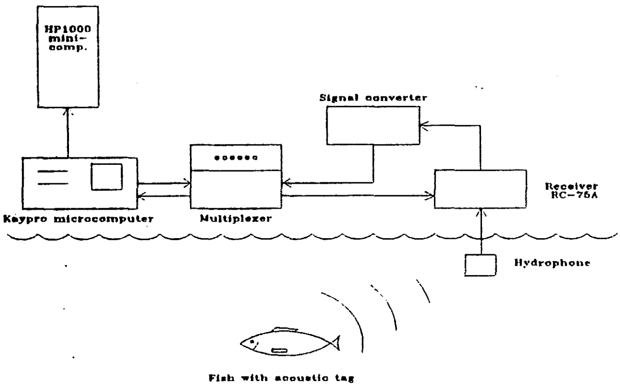


Figure 1.

System overview.

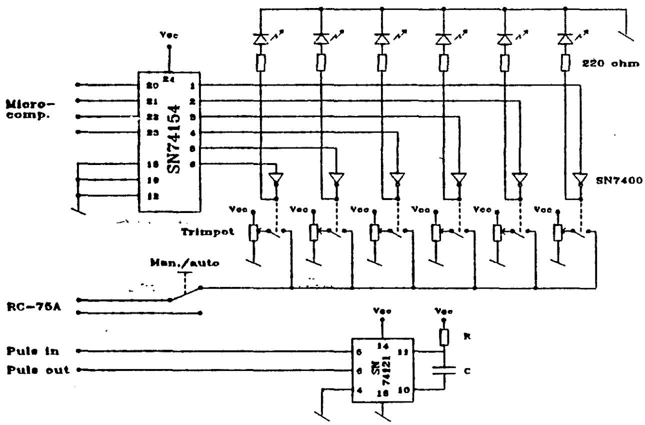
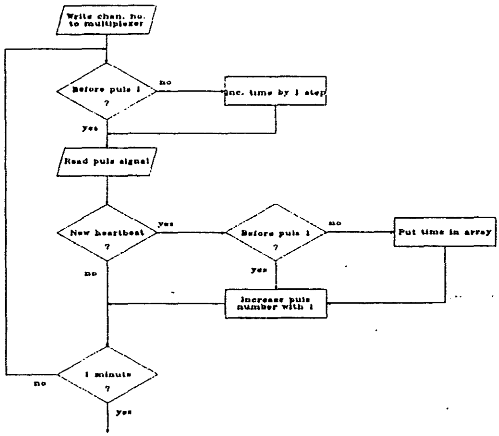


Figure 2.

Multiplexer circuit diagram.

APPENDIX

Reading of pulssignal for 1 chan. in 1 minute.



Error correction of pulsrate.