

A STUDY ON INFORMATION ANALYSIS AIDS FOR
SEA SURFACE TEMPERATURE IMAGE DATA

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Abstract

Sea surface temperature (SST) charts obtained from a satellite includes various oceanic conditions such as fronts, ocean currents, eddies, etc. In extracting these oceanic conditions, simplified processing and high accuracy of the processed results are important. Technology of knowledge based processing is applicable to these problems. In this study, a feasibility study on information analysis aids for SST image data using this technology has been performed. This paper also describes implementation of the prototype knowledge based system.

1. Introduction

Observation of the ocean from Earth orbital altitudes by satellite is extremely effective for obtaining global spatial structures and temporal changes which are difficult by ship observation. The fishery is particularly dependent on ocean observation. In searching fishing grounds, fishermen typically rely on experience of experts because the constant movement of fish in vast seas and time changes of oceanic phenomena make conventional searching by fishing boats prohibitive. Remote sensing by satellite opens up many possibilities for dealing with these problems and it is expected that large economic effects will be achieved, and much research has been done both on industrial applications and in the fields of hydrodynamics and ocean physics.¹⁾

For extracting these oceanic conditions, much accumulated knowledge and experience from conventional ocean observation by ship and other methods have been and will be indispensable. However, this knowledge is not necessarily available in a form

that matches conventional data processing procedures by computers. On the other hand, the knowledge based processing has great possibilities of dealing with an ill-defined problem which has ill-structure of data information and rather requires many interactions between the system and users. In other words, the knowledge based processing is able to introduce expert experience and knowledge for oceans and fisheries. Therefore, the efficient application of the knowledge based processing technology is anticipated to serve as an analysis procedure for extracting oceanic conditions from the SST chart.

2. Analysis of SST Charts

For fishery, water temperature is one of the most important environmental conditions, and a suitable water temperature zone differs by a kind of fish. Direction and speed of ocean currents and eddies are also important factors in predicting a profitable fishing ground.²⁾ Satellite image data is very effective for identifying the position and form of ocean currents, eddies, and fronts by water temperature distribution. Seawater temperature data from an infrared radiometer installed on a satellite is used with data measured by ship to draw up the SST distribution chart.

In the current experimental operation system, by putting a transparent paper with land and longitude-attitude lines on the SST image that is displayed on a CRT display by a computer, the characteristic values of oceanic conditions, such as a warm and cold water mass, eddies, and tongue-like intrusions of the Kuroshio and the Oyashio etc. are drawn (see Fig. 1). Essentials to this process are many processing procedures dealing

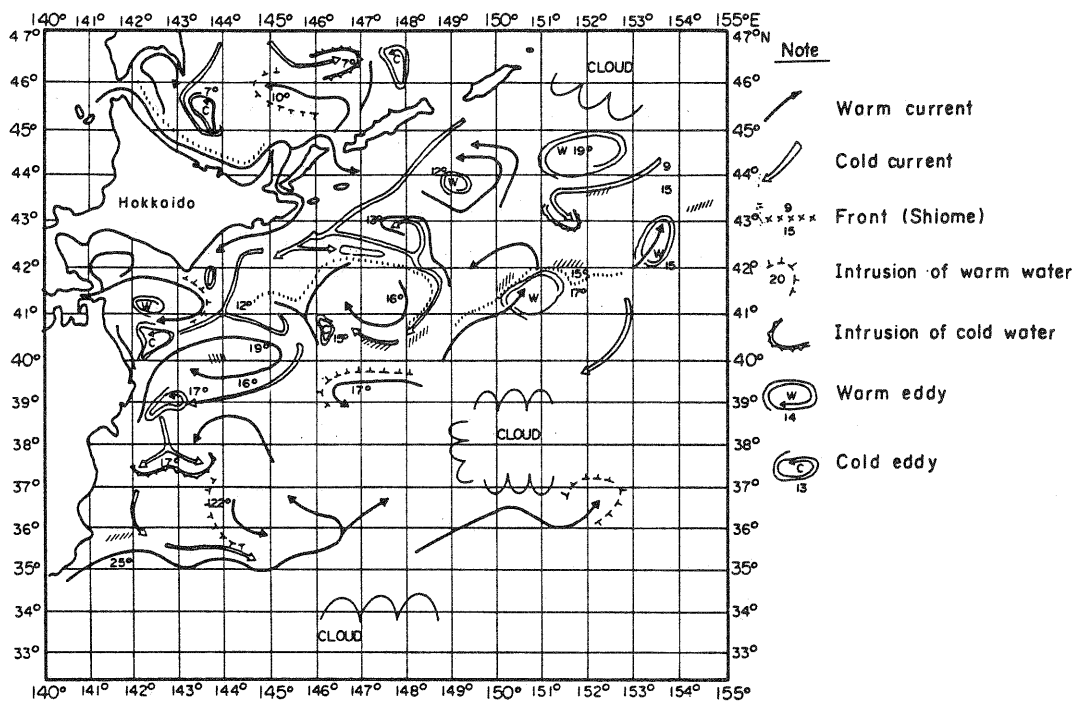


Fig. 1 Oceanic Conditions Chart

with trial and error on the basis of knowledge and experience on oceans and fisheries, image enhancement by judging the existence and size of clouds using multitemporal image data, and others. And some parts of these processes can not be completely systematized in a machine processing form and is in need of large work loads.

3. Systematization of Analysis Support for SST Charts

In analyzing the satellite image data and extracting the oceanic conditions from SST charts, short processing time, objective results, and simplified processing are necessary. A reasonable method for meeting these requirements is to systematize in a computer system the tasks described in the foregoing paragraphs. In other words, the computer processing that is able to introduce expert knowledge and experience on oceans and fisheries is adequate for these needs.

In the systematization, an analysis of existing expert knowledge and experience used in the process of recognizing oceanic conditions are important for the feasibility of the system. An example of this analysis is shown in Table 1, in which only main items for estimation processing of fronts are listed up. In addition to these items, about 50 items have been analyzed for the first stage of systematization. They are knowledge information of the other oceanic conditions, attribute information for satellite image data, output information of the analysis result, and system information needed for systematizing oceanic conditions analysis.

Among this knowledge information, some items are resolved into more detailed processing procedures and corresponded to algorithms for image processing and pattern recognition. To code

Table 1 Knowledge Information for SST Analysis Aids System

kn.1	Fronts are based on inequality: temperature-difference / distance > x.
kn.2	x differs with each position generally.
kn.3	Temperature-difference and distance depend on the sea area.
kn.4	Distances are taken toward the normal line of the front.
kn.5	Fronts exist in the offing rather than in coastal zone.
kn.6	Several fronts sometimes concentrate in parallel.
kn.7	Temperature-slope is large where fronts concentrate.
kn.8	Fronts are formed in curve and intermittent.
kn.9	Front lines do not meet.
kn.10	Fronts agree with the direction of an isotherm.
kn.11	There are sea areas where fronts easily occur.
kn.12	Fronts are apt to occur east and west rather than north and south.

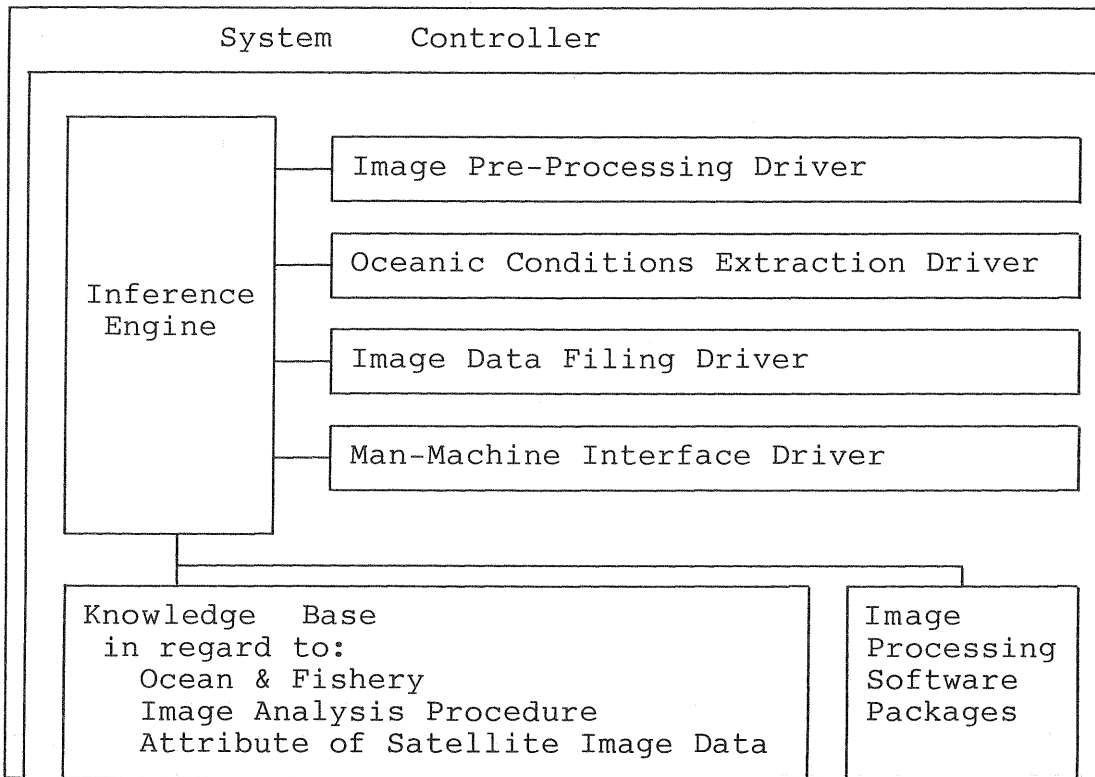


Fig. 2 System of Information Analysis Aids for SST Image Data

the information and algorithms for computer use, a language must be selected that fits the characteristics of each type of information.

4. System Configuration

On the basis of the feasibility study, an aid system for extracting oceanic conditions from the SST, which can introduce expert knowledge and experience on oceans and fisheries, was constituted as shown in Fig. 2. The system is able to be operated under a general purpose operating system in consideration of development environment of image processing and pattern recognition softwares. The implementation of the knowledge data base, the drive and control of analysis processing system, and user interface are done using a command procedure and list processing language considering run-time environment.

In this system, both of the image pre-processing driver and the oceanic conditions extraction driver control image pre-processing and pattern recognition software packages under the inference engine. The packages are described in FORTRAN language for intending the utilization of established softwares which have exchangeabilities with general purpose image processing systems. And the image data filing driver controls image data input/output based on a standard image data format,

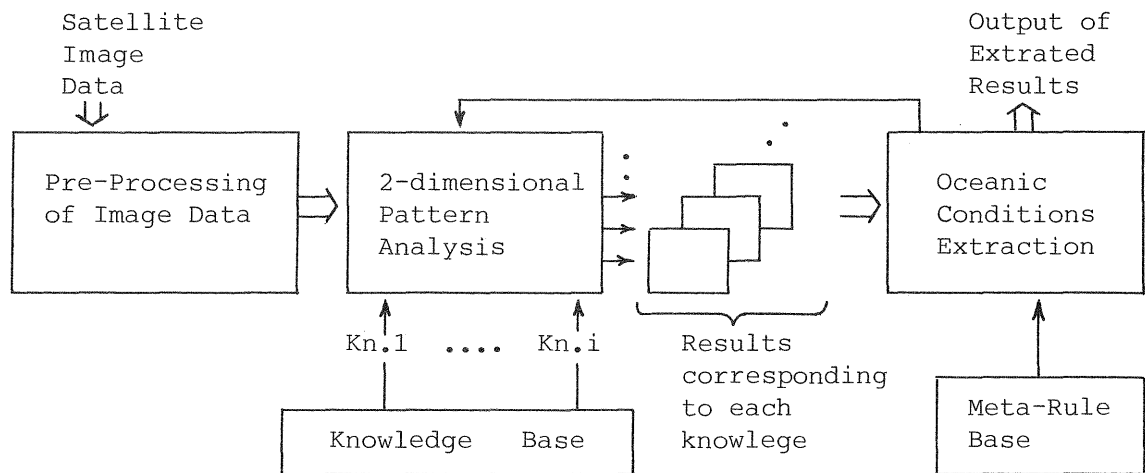


Fig. 3 General Flow Chart of the System

parameter spaces needed for setting the necessary parameters for image pre-processing and pattern recognition, and so on. Moreover, the man-machine interface driver processes the demand of selecting image data, checking parameters for image input/output and file, and explaining system activities for users. And the display format for the man-machine interface can be customized for the user by use of system commands. In Fig. 3, the general flow of operation of a prototype system is shown. An example of display information for user interface is shown in Fig. 4.

An experimental result of the front extraction by this system is shown in Fig. 5. As the input data to the system in this experiment, the SST chart obtained from NOAA infrared image data was used. Data of the area around Japan with 512 pixels

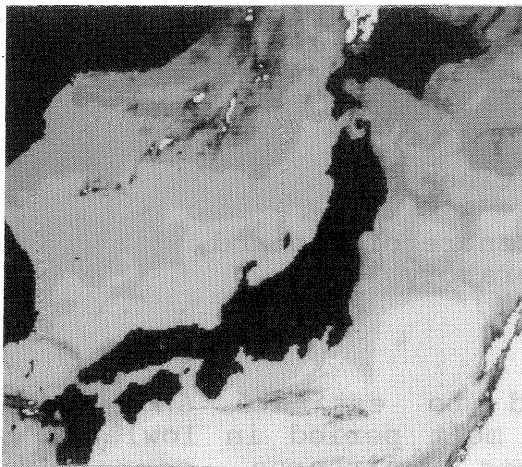
Fig. 4 Example of Display Information for User Interface

*** Front Extraction Aid System ***

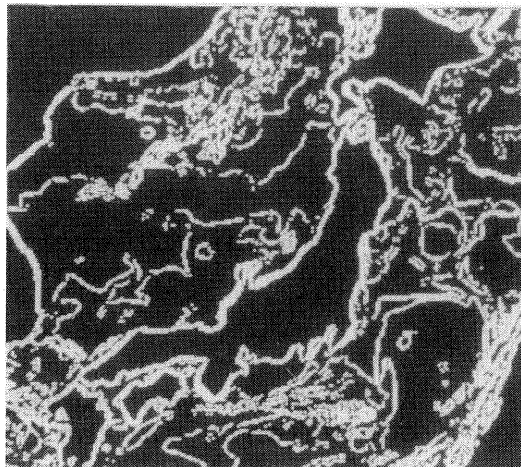
Outline of the System:

- o System starts and screen changes by pressing execution key.
- o Use help function if necessary.
- o Return to any step when necessary.
- o Extraction procedure is as follows:
 1. Execute edge operator to detect candidates for fronts.
 2. Infer whether each candidate is a front using knowledge rules.
 3. Output results of front chart.
 4. Store image results in file.

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Input Data



Extracted Result

Fig. 5 Result of Front Extraction by the System

by 512 lines of 8 bits per pixel were processed. The extracted result of the front can be displayed in colors.

5. Concluding Remarks

The system in this study can extract oceanic conditions with two dimensional patterns from SST charts using expert knowledge base on oceans and fisheries in a reasonably short time. The system has the following remarkable features: powerful support for analyzing marine observation satellite (MOS) image data and producing oceanography charts, high system performance using expert knowledge base on oceanography and fishery, and flexibility for the future system expansion.

Following the prototype system on the basis of the feasibility study, the advanced knowledge based system is planned. The future developmental stages of the system are as follows: extraction of oceanic conditions with a higher accuracy by using image sequence analysis, and production of fisheries oceanography charts with predicted fishing grounds and oceanic conditions.

This study is being conducted with a supply of MOS-1 satellite data from the National Space Development Agency of Japan.

References

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