Information Access Method to Meteorological Data for Educational Application

Masashi Toda, Ayako Osanai, Ayahiko Niimi, Junichi Akita, Ken-ichi Kimura, and Osamu Konishi

School of System Information Science,
Future University-Hakodate JAPAN
Faculty of Engineering, Kanazawa University, JAPAN
E-mail { toda, m1201134, niimi, kimura, okonishi} @fun.ac.jp
akita@is.t.kanazawa-u.ac.jp

Abstract: In this research, we propose the efficient access method to meteorological data which we collect in Teiten 2000 project. We often relate meteorological data to weather phenomena, such as fine, cloudy, snowy, foggy, and so on. Depending on this hypothesis, we add meteorological data to attribution of weather phenomena, and construct searching system using this type of attribution.

Introduction

It is very important to study change or regularity of the weather using real meteorological data in meteorological education curriculum of elementary school or junior high school. Meteorological observation data which the meteorological agency provides is often used. We can get these data by meteorological satellite, and these data are efficient to study meteorological phenomena of whole Japan. But observation area of these data is very wide, so students can not understand as familiar subjects. In order to solve this problem, Teiten2000 project started in 2000. In this project, we put meteorological observation sensors and cameras at several sites in Japan, and are collecting meteorological data. The purpose of this project is to assist science educational program for elementary school or junior high school using meteorological data which we collect. Future University-Hakodate, where we belong, is one of the sites, and we are collecting meteorological data and images continuously from Sep., 2000. We get meteorological data every 5 minutes, and a meteorological image every 10 minutes in daytime (every 1 hour in the night). Four years has passed since Teiten2000 project started, and the amount of data and images is very huge. So it is difficult to access data which we collect. These data have already fundamental attribution information, such as date/time which data are collected, but it is not convenient to search data by only fundamental attribution information.

In this research, we propose the efficient access method to meteorological data which we collect in Teiten2000 project. We often relate meteorological data to weather phenomena, such as fine, cloudy, snowy, foggy, and so on. Depending on this hypothesis, we add meteorological data to attribution of weather phenomena, and construct searching system using this type of attribution.

Weather phenomenon

Weather means general status of the atmosphere that notices atmosphere phenomena and cloud. In Japan, weather phenomenon is decided by the table of weather types which is made in advance. Table 1 shows a part of the table of weather types. The amount of cloud in table 1 means the ratio of sky which is covered with cloud, and is expressed by a number from 0 to 10. View range means the length about visibility.

Table 1 The table if weather types (partial)

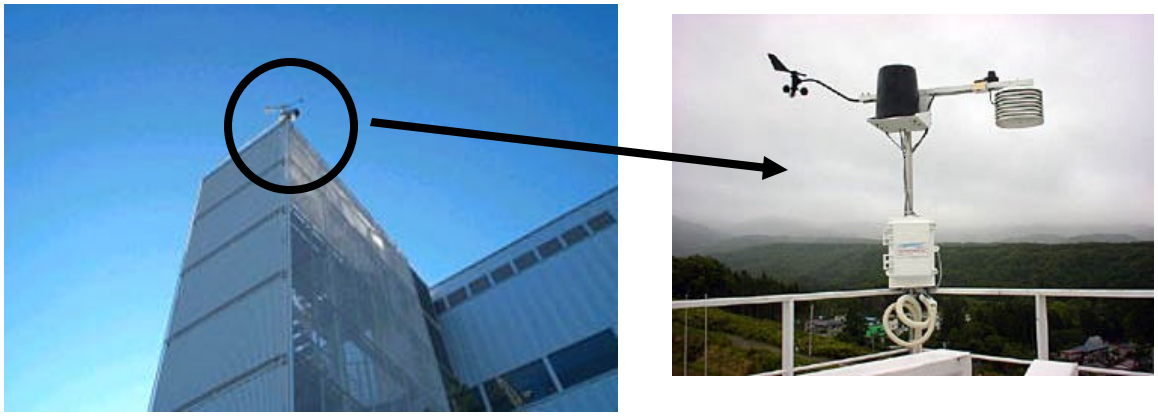
Weather type number	Weather	Explanation
1	Clear weather	The amount of cloud is less than 1.
2	Fine weather	The amount of cloud is from 2 to 8.

4	Cloudy	The amount of cloud is 9.
8	Foggy	View range is below 1km.
9	Misty rain	Misty rain falls.
10	Rainy	Rain falls.

Weather Judgment Algorithm

Design of Weather Retrieval System

As mentioned above, the meteorological observation system in Teiten2000 project collects meteorological data every 5 minutes, and images every 10 minutes in daytime (every 1 hour in the night). Figure 1 shows the meteorological observation system, where is at Future University-Hakodate, in Teiten 2000 Project. We do the weather retrieval using these data. Figure 2 shows the design concept for weather retrieval system.



(a) Sensor module for meteorological observation.

(b) Camera module for meteorological observation

Figure 1 Meteorological observation system in Teiten2000 Project.

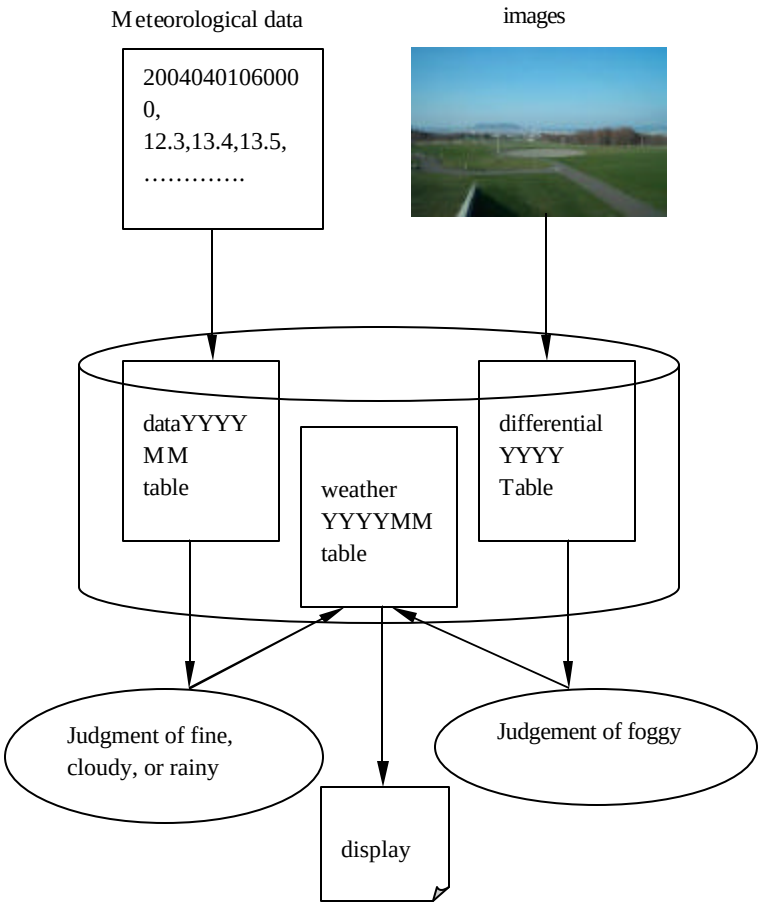


Figure 2 Design concept for weather retrieval system.

Judgment about Cloudy

We judge whether it is cloudy or fine by solar radiation intensity and estimation of an amount of global solar radiation. We can observe solar radiation intensity by a sensor, and we can estimate an amount of global solar radiation by solar radiation out of the atmosphere and sunshine duration.

Judgement about Foggy

We judge whether it is foggy or not by images. We consider to be foggy when the sum total of differential value of images is not more than a threshold value, because an image when it is foggy is not clear, and it is considered that the value of edges in the image is few. We get the differential value of an image using a Sobel filter, and get an gradient using a differential value by x-axis and a differential value by y-axis. Formula (1) shows Sobel filter f. A gradient is acquired by formula (2).

$$f_x : \begin{pmatrix} 1 & 0 & -1 \\ 2 & 0 & -2 \\ 1 & 0 & -1 \end{pmatrix} \qquad f_y : \begin{pmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{pmatrix} \tag{1}$$

$$g[i, j] = |\Delta_x f| + |\Delta_y f| \tag{2}$$

The threshold value in order to judge whether it is foggy or not is acquired using dynamic threshold decision method.

Judgement of Rainy

We judge whether it is rainy or not by the output from a precipitation sensor. Variable rainfall means the output from a precipitation sensor, and

if rainfall > 0 then rainy
if rainfall = 0 then not rainy

Weather information accumulation table

Table 2 shows the format of meteorological data accumulation table which attribution information is added to.

Table 2 Weather information accumulation table.

Date	image	fine	cloudy	rainy	foggy
XXXXYYZZAABBCC	filename	bool	bool	bool	bool

A “date” field has date and time information which meteorological data is observed. XXXXYYZZ shows a date, and AABBCC shows time. A “image” field has a filename of data. “fine”, “cloudy”, “rainy”, “foggy” shows the weather condition by Boolean algebra. If it is fine, A “fine” field shows TRUE, and the others are “FALSE”. If it is a bit cloudy, “fine” and “cloudy” fields are “TRUE”, and the others are “FALSE”.
We can search meteorological data and an image by weather phenomena (fine, cloudy, a bit cloudy, and so on), when we use this table.

Experimental Results

Figure 3 shows the result of weather retrieval system which we construct. This result is the meteorological data and images on Apr. 2004.

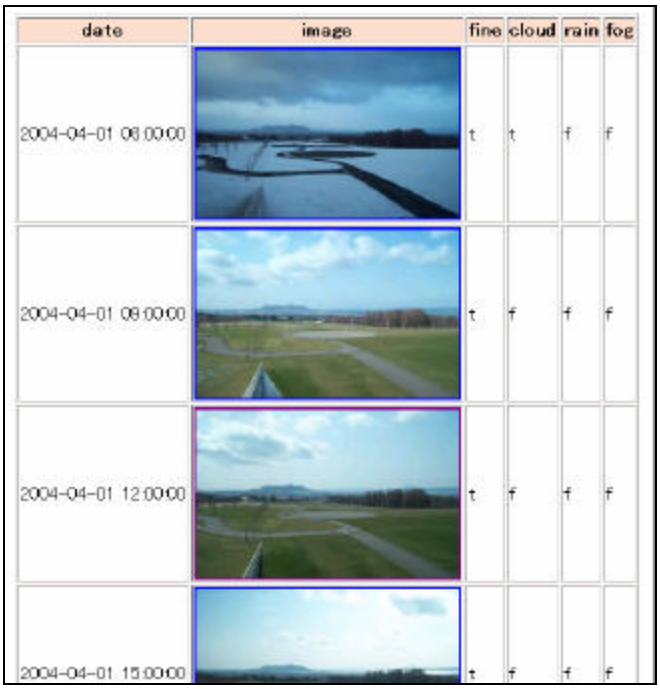


Figure 3 Result of weather retrieval system.

Educational Application

Depending on the teaching guideline about an elementary school and a junior high school by Japanese government, students study meteorological phenomena in 5th grade of an elementary school and a junior high school. In 5th grade of an elementary school, students observe weather conditions of a whole day in order to understand a change in the weather. In a junior high school, students observe familiar meteorological phenomena in order to understand a regularity of a change in the weather. We propose examples of syllabus planning about each grade using our system.

Curriculum for 5th grade of an elementary school

Example) A change in the temperature in a whole day.

Students look over a change in the temperature in a whole day, and make a graph of the result. If it is fine, it is considered that a graph looks like a mountain. If it is cloudy or rainy, it is considered that a change of a graph is smaller. In a class, students look at a graph and an image at the same time. Through this experience, students can understand a relation between a weather condition and meteorological data.

Curriculum for a junior high school

Example) Relation between a fog and meteorological data, such as temperature, humidity and so on

Students can see meteorological data, such as temperature, humidity, atmospheric pressure, and so on, when it is foggy. Through this experience, students suppose a occurrence mechanism of a fog in an observing site.

Conclusion

We propose the efficient access method to meteorological data which we collect in Teiten2000 project. We add meteorological data to attribution of weather phenomena, and construct searching system using this type of attribution. We also propose the educational programs using our system. We analyze meteorological data and images using empirical knowledge. In the future, we try to data mining method for analysis, and plan the display mechanism.

Acknowledgements

We thanks Dr. Masami Tokuno of Hakodate Marine Observatory for helpful discussion.

References

Teiten 2000 Project, http://www.teiten2000.jp/

Toda, M., Akita, J., Kimura, K. (2003) Construction of Ubiquitous Weather Observation System. Proc. of The 7th World Multiconference on Systemics, Cybernetics and Informatics (SCI2003), Vol.1 pp.192-197.

Akita, J., Toda, M., Kimura, K. (2004) Handy Meteorological Observation System for Hands-on Study. Proc. of The 8th World Multiconference on Systemics, Cybernetics and Informatics (SCI2004), Vol.X pp.155-159.