Analysis of Flood Flow by Stereomaching Method

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ABSTRACT

Former analysis of flood flow is observation of relief that is caused Cameron effect in river by operator. But it is able to obtain velocity vectors on the water surface automatically by using stereomatching method. Analysis of flood flow by stereo matching method can get more delicate change of velocity vectors than former analysis. And, it is able to obtain various kinds of analytical value (divergence, rotation, etc.) by calculation. So, using analysis of flood flow is possible to realize riverbed forms.

It is interesting to use HDTV's image in place of aerial photographs. Because time interval of video imagery is shorter than aerial photographs, change of imagery caused by time interval is smaller. Then, analysis results by video imagery are may be more exact than analysis results by aerial photographs.

1. ANALYZING USING AERIAL PHOTOGRAPHS

1.1 Purpose of Analysis of flood flow

If we can measure velocity direction of flow, water level, rate of discharge flow, etc, we can get available base data for flood control. Once we used stereo plotter to analyze flood flow. We got velocity vectors to plot change of floating matter and bubbles on aerial photographs. And we plotted velocity contour caused Cameron effect.

Kinosita developed these analysis of flood flow method using aerial photographs in 1960's.

We could get new knowledge about meander and structure of turbulent flow in flood time. Kinosita based this method to probed about sandbar on river bed, big vortex occurred in river edge, phenomenon concerning drift of earth and sand, etc. And he has to contributed to river technology field, for example planning on river channel.

But, this method has some problems.

(1) Measurement data is decided by operator to use stereo plotter.

(2) Direction of photographing base must be parallel to the direction of flow in river to measure velocity using Cameron effects.

(3) Flight course is restricted from problem (2), and operation of flying machine is dangerous.

(4) To analyze flood flow in camber or meander, which radius curvature is small, is too difficult.

Utami, Ueno developed to get velocity vectors without these problems by stereomaching method.

1.2 Cameron Effect

If exposure interval is enough short and there are many floating matter and bubbles, we can observe velocity distribution as 3D relief on river surface. This phenomenon is called as Cameron effect.

2. ANALYSIS BY STEREOMACHING METHOD

2.1 Stereomaching

Analysis of aerial photograph images by stereomaching method has been developed since end of 1950's to

generate contours of map from aerial photographs automatically. (C. Mori, et al 1981)

The problems of stereomaching are follows.

(1) The capacity of images data is very large. From this problem it takes large time to deal with images from this problem.

(2) The correlation coefficient become lower caused of projective distortion influenced by terrain relief. From this problem, we can't do stereomaching in area of good concealment.

In analysis of flood flow, it is not necessary that high correlation coefficient is high accuracy, because density of floating matter and bubbles are different in two photographs. On the other hand, the plane including river flow is so flat that we can disregard projective distortion. So some ideas is necessary to use stereomaching method for analysis of flood flow.

2.2 Adaptation for Analysis of Flood Flow

To solve above problems about stereomaching method, we adapt follow ideas.

(1)Process time

The most available method to cut short process time is to restrict area for searching stereomaching method. The method called as coarse-to-fine method is considered to restrict the area. We use two step coarse-to-fine method of area correlate for stereomaching in this work.

(2)Projective distortion

We can disregard projective distortion caused by terrain relief assuming that the plane including river flow is flat. And this assumption is reasonable. So we adjust positions in two photographs by secondary projective translation using same points in two photographs.

2.3 Advantages of Stereomaching Method

Analysis of flood flow by stereomaching method has following advantages compared to analysis of flood flow by method using stereo plotter.

(1) We can get digitized velocity vectors directly and objectively by method of area correlate.

(2) For this method is calculation process by computer, we can get quickly more velocity vectors than method using stereo plotter.

(3) Analysis of flood flow by stereomaching method isn't restricted by direction of flow. So it is comparatively

easy to shot photographs. And it is able to analyze in camber or meander.

(4) It is able to calculate some quantities of hydrography (divergence, rotation, etc.) and to plot each quantities. Also, from each quantities of hydrography we can analyze structure of vortex in river edge or movement of river bed. (T. Utami, et al 1992, R. Kinosita, et al 1990)

3. EXAMPLE OF ANALYSIS OF FLOOD FLOW

3.1 Digitizing photographs

We analyze using color aerial photographs shot on drainage of Kitakami river at August 8th,1995. Exposure interval is about 5.0sec. We digitized these aerial photographs as 24 bits data for each pixel using scanner (Intergraph, PS-1). Pixel size is 30 μm. We convert these data from 24 bits data to 8 bits data for one pixel. Also, we adjusted sensitivity of CCD to get histogram most widely of region in river on scanning time.
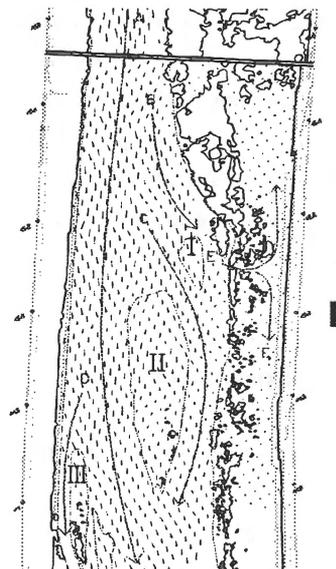

Figure 1 Velocity vectors of Kitakami river

3.2 Result and consideration

We indicate velocity vectors on surface got by stereomaching method at Figure 1. We grouped flow in river from velocity vectors. (Figure 1, flow :A,B,C,D,E) There are three sandbars.(Figure 1, sandbars : I,II,III) From bridge to lower course A(main flow) became wide and weak as width of river becoming big. And B,C,D

appeared as tributary of main flow. B flowed from neighboring 45.5km post. C flowed along river edge on left side from neighboring 45.2km post. A and B,C jointed at 44.6km post. And D flowing along river edge on right side was separated from A this neighborhood.

We consider these flows connect with terrain on river bed. It seems that B was separated from A by sandbar I, C was separated by sandbar II, D was separated by sandbar III. Also, the speed of main flow was decreased by separation to B, to C, to D.

4. ANALYSIS USING HDTV'S IMAGES

If we can get good velocity vectors by stereomaching method, we can get very available quantities of (velocity contour, distribution of divergence, distribution of rotation, discharge, and so on) from these velocity vectors. On the opposite side, if we get velocity vectors no well, to analyze flood flow dose not make good meaning.

How can we get good velocity vectors ?

(1) First, it is prerequisite to shoot high quality photographs and to digitize suitably for analysis of aerial photographs. It is important to develop technology shooting and digitizing

(2) Resolution of digitized image is important factor.

(3) To decide the most suitable values of parameters (size of correlation window, interval of start points of velocity vectors, etc.) for stereomaching is important.

4.1 Influence of Exposure Interval

We consider that exposure interval becomes shorter, correlation of two images would be higher. Because change of two images become small in short exposure interval. But there is limit for exposure interval using aerial photographs. So we use HDTV to get images taken by very short exposure interval. The exposure interval of HDTV's image is 1/30sec for one image.
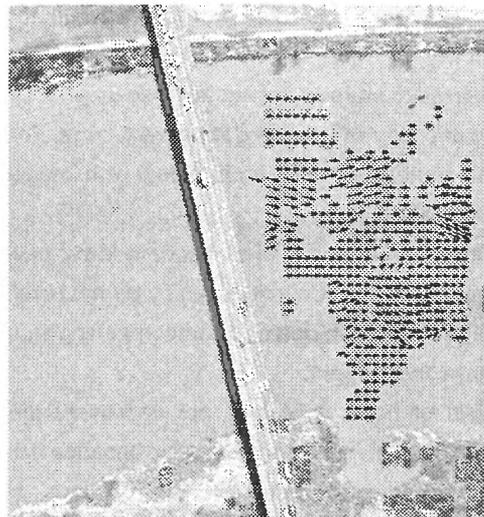

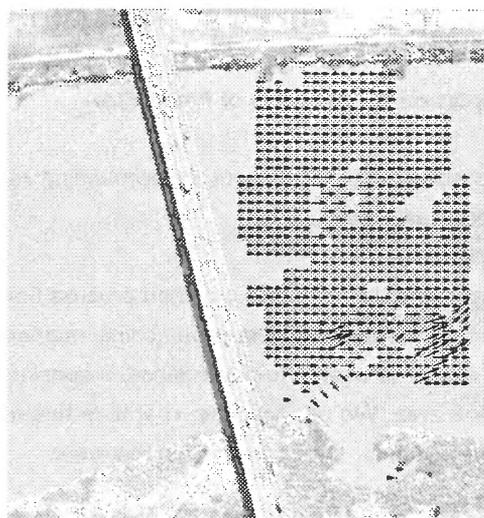**Figure 2 (a) Velocity vectors from 2.0sec interval**

Figure 2 (b) Velocity vectors from 1.0sec interval

4.2 RESULT OF ANALYSIS USING HDTV

4.2.1 Results by Various Exposure Interval

We shot HDTV's image on drainage of Yodo river at March 16th, 1996. Pixel size is 0.33m on ground coordinate. We got velocity vectors using images by each exposure interval is 2.0sec and 1.0sec. (Figure 2 (a),(b))

By these results, we get speed of river flow as about 1.0m/s.

Also, we tried to analyze flood flow using images by each exposure interval is 4.0sec and 0.5sec. But we couldn't get good velocity vectors because of following reason.

Using 4.0sec exposure interval images, change of two images is too big, and correlation in two images is too low.

Using 0.5sec exposure interval images, change of two images is too small compare with pixel size.

In this way, using HDTV has an advantage to select images in optional exposure interval meeting purpose to use analysis of flood flow. In this way sandbars influence flood flow very significantly.

4.2.2 Inspection of Analysis by Eye Measurement

We get velocity vectors by eye measurement to inspect velocity vectors by stereomaching method . (Figure 3)

Comparing Figure 2 with Figure 3 we consider that we can get more good velocity vectors using 1.0sec exposure interval images than using 2.0sec exposure interval images entirely.

We selected 20 points to compare with each velocity vectors on place that suitable stereomatching was done. Mean value of dV_1 is -0.4m/s and standard deviation is 0.3m/s. Mean value of dV_2 is -0.3m/s and standard deviation is 0.3m/s. Where dV_1 is discrepancy of velocity by eye measurement and velocity by stereomaching using 1.0sec exposure interval images, dV_2 is discrepancy of velocity by eye measurement and velocity by stereomaching using 2.0sec images. From these results we consider as follows.

(1) Using stereomaching method, it seems that there may be some systematic errors which don't depend on exposure interval.

(2) If suitable stereomatching is done, velocity vectors have similar accuracy.

(3) Since exposure interval is small using HDTV, the resolution of speed becomes big. So if we want to get enough numeral accuracy, we need more small pixel size on ground coordinate than using aerial photographs.

Figure 3 Velocity vectors from eye measurement

5. CONCLUSION

We have mentioned about analysis of flood flow by stereomaching method. Finally we mention about matters and problems that we have to remark considering future of this method.

(1) Because results of analysis by aerial images is concerned with phenomena on surface of river, it is important to connect these result with result of analysis concerning with phenomena inner river flow by man-made channel in laboratory.

(2) When we analyze natural phenomena such as flood flow, simulation have often very significant meaning. Stereomaching method using HDTV has high reality to achieve simultaneous analysis. Because we don't have to do development and digitizing of photographs and don't have to operate stereo plotter. If we can analyze simultaneous on flood time, the significant and interest of this method will be larger.

(3) Using HDTV we can shoot images in lower altitude than using aerial photographs. So possibility shooting images, when there are clouds in the sky, is large.

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