Image Analysis Technique Using RGB Value Toward Realization of the Auto-sensing of Regime Change - A Case Study in Kurodakesawa River -

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INTRODUCTION

As many CCTV cameras have been installed along mountain streams across Japan, if their images are automatically analyzed and effectively used, further enhancement of the monitoring system can be expected. The image analysis research so far conducted has engaged in downstream detection of avalanches, forecast of water level and flow rate, and so on respectively. However, there have not been approaches to using an algorithm covering the change of flow such as water level, turbidity of water and detection of dynamic fluidity totally. As there are various forms of flow state change such as debris flow and flowing out of gravel and sand along mountain streams in addition to flash floods caused by heavy rain, the limited detection algorithms so far made lack general applicability when it comes to evaluating phenomena.

Therefore, we tried to research and develop image analysis techniques that can monitor and observe the change of flow state by grasping phenomena in a versatile way. We focused on RGB value of pixels based on images of features of debris flow's motion observed when the flow state changes.

FEATURE OF THE DEBRIS IMAGE

Using CCTV images (AM 6:53:45–AM 6:57:13) of a debris flow that occurred along the Kurodakesawa River, one of Ishikari River systems in Hokkaido on August 23, 2016, a prototype of an algorithm for detecting change of flow state was made. The images included those starting at 6:53:45 when turbid water had already been generated, those showing the water level reaching its peak at around 6:55 due to step waves of debris flow, and those until 6:57:13 when the water level slightly descended (**Fig.1**). They show that brown-colored areas occupying the flow route increased due to flow of the turbid water and flow down of step waves of the debris flow. The pixels of water surface images were disturbed every second as time passed.

METHOD

We used three channels as pixel information composing images, i.e., R (red; λ=700 nm), G (green; λ=546.1 nm) and B (blue; λ=435.8 nm) were used. From images of clear water and turbid water, RGB values were extracted and, by comparing differences

Fig.1 Motion images of debris flow taken by a CCTV installed along Kurodakesawa River

between them, whether or not RGB values were meaningful as indices of a method for detecting turbidity was studied.

RESULTS

By designating analysis target area ①(right-hand side river wall) and the analysis target area ②(water surface) within the images, RGB values of each pixel within the analysis target areas were extracted as 24-bit data (8 bits/channel). RGB values of each of these pixels were averaged and organized time-sequentially for each frame (**Fig.2** to **Fig.4**). When step waves of debris flow arrived at around 6:56:40, the turbid water was reflected in the analysis target area ② and the RGB values increased from approximately 85 to 90 up to 100 or above (**Fig.3**). Meanwhile, in case of the analysis target area ②, water surface of turbid water was always reflected and it was confirmed that the R value showed a relatively higher value among RGB (**Fig.4**).

In the case of debris flow of August 23, 2016, there are no images that we could obtain before becoming muddy besides another day. By using images of November 15, 2016, RGB values of clear water surface were extracted similarly (**Fig.5**, **Fig.6**). By observing the pixel information of clear water surface, it was found that, unlike turbid water, the B value becomes relatively great in the order of B>G ≈ R.

CONCLUSION

(R, G, B) vectors of Kurodakesawa River were (95, 99, 117) on the clear water surface and (165, 150, 137) on the water surface at the time of arrival of step waves of debris flow, and the unit vectors were respectively (0.53, 0.55, 0.65) and (0.63, 0.57, 0.52). Therefore, it follows that when turbid water is generated, the R component of (R, G, B) vectors increases. A series of motion images of pre-post-turbidness were not obtained. However, by observing difference of (R, G, B) vectors and their unit vector of clear water and turbid water, possibility of detecting occurrence of turbid water were suggested. As a next step, it is necessary to conduct quantitative evaluation in relation to the unit vector of (R, G, B) vectors and turbidity. Meanwhile, because of depending on flux of insolation, it is a future task to be solved that the relationship among sunshine conditions, pixel information and turbidity of water will be clarified.

To conclude this study, we would like to express our sincere thanks to the Hokkaido Development Bureau which kindly provided us with CCTV images of Kurodakesawa River.

Keywords: Image analysis technique, auto-sensing, turbidity and water level observation

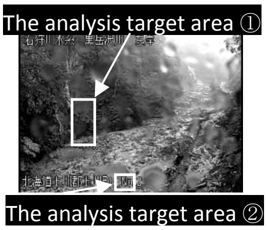

Fig.2 Kurotakesawa River (at the time of debris flow) and designation of analysis target areas ① and ②

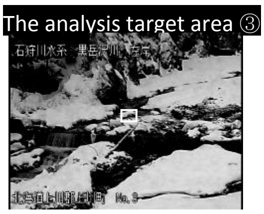

Fig.5 Kurotakesawa River (ordinary level) and designation of analysis target area ③

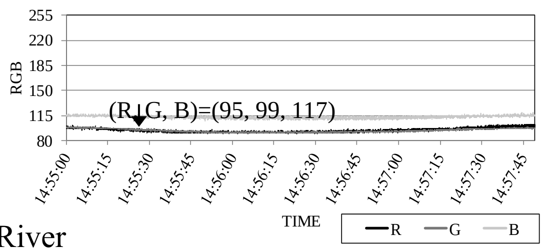

Fig.6 Time sequential change of RGB values in the analysis target area ③

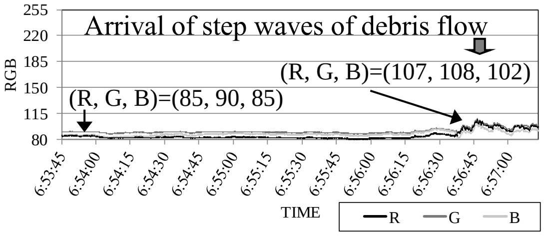

Fig.3 Time sequential change of RGB values in the analysis target area ①

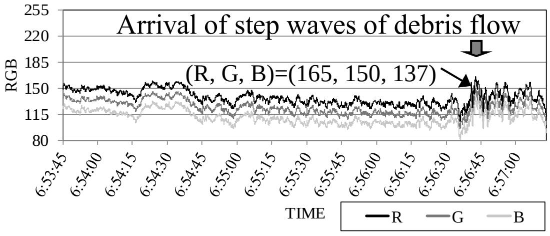

Fig.4 Time sequential change of RGB values in the analysis target area ②