Algorithm for Detecting the Image of River Sediment Based on Hydrometric Cableway

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***Abstract*—In order to solve the long period of drying method in river sediment conditions, an image acquisition device which installed in the lead fish existing in Cableway river is designed. This new device sinks into the pre-set the vertical position, when the computer of bank workstation issuing control commands, the camera in lead fish started to sample recording in the water, and image transfer to the image acquisition card, and then transmitted image data to the banks of workstations by the ARM. After denoising, segmentation, calculation and processing to images by computer in riparian workstation, the river sediment content is done.**

The measurement of the river sediment proposed by this paper is adequate for the lower detection (30kg/m^3), and used in Ji'an Wu River hydrological station. Applying the presented method it is shown that comparing with traditional method the presented method has reduced in time 96% and compared with the drying method error of 1% -% 5, which meets hydrology and sediment survey. Although the method for larger sediment (100kg/m^3) river sediment concentration measurements still short of expectations, but it can provide a reference for sand measuring.

***Index Terms*—sediment content, underwater camera, image processing**

I. INTRODUCTION

China is multi-country river sand, silt issues stood out. In water conservancy and hydropower project construction, hydrological observation forecasting, soil erosion studies, soil erosion, the river sediment of the measurement is an important topic. With the modernization of China's development of hydrology and water resources information collection, transmission, processing and prediction of intelligence have been gradually speed up the construction progress of the hydrological work flow measurement, measuring sand, measuring rainfall is heavy throughout the hydrological work in the weight, the accuracy of these monitoring data for China's flood control and drought and water management conservation significance. Among them, the monitoring of river sediment directly to China's water conservancy construction, environmental protection and soil erosion and provide scientific basis for the development of close relations with the local economy. Now the water table, flow monitoring has been achieved-line real-time monitoring, but monitoring of sediment still in a backward state, affected line real-time monitoring of small rivers and hydrology (water level, flow, sediment concentration) data intelligent speed of development, a serious obstacle a small river floods, drought and timely forecasting [1]. Therefore, online monitoring of river sediment content in the field of hydrology has become an urgent need to address one of the important issues. Determination of river sediment is suspended sediment sampler, a certain volume of water samples collected by water samples after treatment measured by dividing the weight of dry sand in which water sample volume, that is, the water of the sediment samples. Traditionally, river sediment traditional method of measuring sediment sample weighing method is used, that is to take a certain volume of a representative sample of the water samples, after pretreatment, and then drying, weighing, you can seek knowledge and sediment concentration[2][3].This approach depends largely on the representative ness of the samples taken, and the measurement cycle is long, cumbersome operation, labor-intensive and can not flow well in real-time monitoring of the dynamic process.

Jiangxi Province is very rich in river runoff, the river's annual flow of the Gan River to the largest near the Yellow River basin, the annual total amount of water. Ji'an City is located in the Midwest of Jiangxi Province, Gan River middle reaches, in addition to Gan River, there are Heshui, Lushui, Wujiang, Shu water, Suichuan River tributary in the catchments area of more than 1,000 square kilometers of rivers are 8, greater than 100 square kilometers with 32. As Jian area green area, soil and water conservation is better, apart from a few sediment Gan River and other large rivers is limited, the Jian river sediment 80% of the region were less. And Ji'an region a total of 20 hydrological stations, the sediment concentration of the test were powered by 48 and 12 hp motor boats Shi measurements, sediment information on computer integration, hydrological station staff work intensity, low efficiency[10]. Therefore, a major study of this paper is measurement of its sediment content in

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technical methods on-line on the lower river sediment (sediment content<30kg/m^3). The technology program will be under construction, soil and water conservation of China's ecological environment monitoring network provide an important basis for front-end data, and will be an important contribution to the efficiency of sediment survey, data collection security, improving the reliability of sediment measuring equipment. The success research can greatly enhance of Ji'an standards of testing soil and water conservation areas to promote soil and water conservation study of the modernization process, and further expand the social impact of hydro-power and raising the social status of hydrology for the Jian city's economic and social sustainable development and water resources The unified management and sustainable use of scheduling to provide more powerful support.

II. THE FOREIGN AND DOMESTIC STUDIES

Developed countries are relatively earlier in the river sediment measurement techniques, new method of measuring river sediment, new technologies are emerging in endlessly, the traditional instruments is constantly being improved, in addition to the above method of measuring the sand, some of the latest related measured technology are also researched. Such as conductivity method, vibration method, isotope method, ultrasonic, and laser method.

United States Geological Survey Bureau has designed a vibration-type sediment concentration meter, and its working principle is to measure the vibration period of metal tube which is mixing water at both ends. According to the relationships between the sediment concentration and the vibration cycle , then determination with sediment. U.S. Geological Survey has developed durchgangsrohr, U-tube, such as several forms, and the water temperature is compensated, in the further development and improvement is possible after the application of flow and sediment transport measurements, but short of measuring range.

The ultrasonic measure study is put forward abroad in recent years. Ultrasonic measuring instrument is based on the ultrasonic attenuation in the troubled waters to measure the sediment of water. Canada produces the instrument with a measuring range of 0.5 ~ 70kg/m3, but after the field measurements in the United States it shows that the lower sediment concentration, the worse accuracy.

50 to 70 years of the 20th century, China's river sediment measurements mainly use the horizontal sampler; this apparatus has high reliability and easy operation. However, due to the natural river flows are generally turbulence, sediment has a significant ripple phenomenon, this instrument measured sediment concentration is an instantaneous value by sediment ripple effects of the shortcomings with the occasional large errors.

80s to 90s, measurements of sediment in each hydrological station is normally used time-integrating sampler, such as bottles sampler, pressure regulating sampler, bladder-type sampler, suction sampler. Pressure regulating sampler which has a Surge tank can balance the pressure generated by the natural water flow and eliminate the influence for sudden infusion of sediment concentration in water samples representative of the sampling process, the flow rate of imports is basic stability, imports flow close to natural flow rate, sampling lasted long, and eliminated the effects of sediment pulse. But it has the following shortcomings, firstly sampler in the sampling process of the nozzle to produce the sand on the sediment concentration errors; secondly sediment mixing in the whole cross-section measurements, the depth of flow in case of emergency, due to sampling device in the water too long, the nozzle is not completely closed to prevent the ingress of water when it is not sampling, there will be excess capacity, much higher than the effective volume, and even returned to water storage tanks with water exchange regulator, will result in errors[3][7].

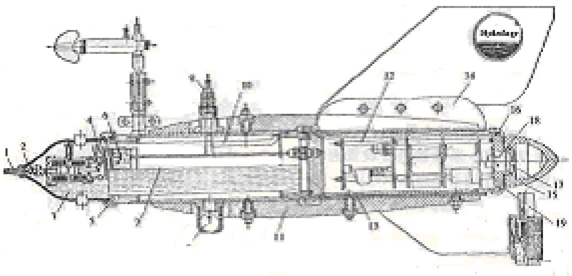
Recently, the Shanghai M-SCORP Measurement Technology Co., Ltd. developed "acoustic density" sand test equipment. The instrument uses the principle of sound attenuation, sound waves through the muddy water with sediment, the particles due to viscous resistance and the physical phenomenon of reflection attenuation of two kinds, so that the received acoustic wave amplitude decreases with the increase of sediment concentration, output analog sediment concentration corresponds the measured value. However, the practice shows that the ultrasound measurements for a particular sand trap, when the sediment reaches a certain value, the return wave amplitude is small and unstable for practical use difficult. The instrument is also further improved.

III. IMAGE-BASED DETECTION METHOD RIVER SEDIMENT DESIGN

Method based on image detection technology is the use of river sediment underwater camera device, in the artificial selection sub-sections on the basis of hydrological norms based on the measurement points on each section for image acquisition, image data collected were transferred to the bank computer workstation , the computer will follow the procedures set up for each measuring point of the image de-noising, segmentation, computing and statistics, generate the entire content of river sediment.

A. *When the product of a traditional sampler sampling process*

Traditional hydrometric sediment is suspended sediment sampler, a certain volume of water samples collected by water samples after treatment measured by dividing the weight of dry sand in which water sample volume, that is, the water of the sediment samples. Commonly used test equipment mainly for the plot when the sampler, such as bottles-type sampler, pressure regulator, when the plot-type sampler, bladder-type sampler, suction sampler[3]. At present, the hydrological station is basically when you are using a voltage regulator integrated sampler, its structure shown in Figure 1.



(1 – Inlet pipe 2 - Magnetic Switches 3 - Sample Class 4 - switch 5 - the first hat 6 - Vent 7 - Voltage Class 8 - Lead-out 9 - Float 10 - regulator tube 11 - lead fish 12 - command module 13 - capsule 14 - tail 15 - End cap 16 - Press Circle 17 - Capping 18 - Power Switch 19 – River bottom signal)

Figure 1. when the voltage regulator integrated sampler chart

Requirements of depth integration for sampling are:

(1) Sampling devices should be lift or down with even speed;

(2) When the water depth is less than or equal to 10m, lifting, vertical speed should be less than the average velocity of 1 / 5; When the water depth is greater than 10m, lifting, vertical speed should be less than the average velocity of 1 / 3;

(3) Sampling with depth integration, a class of station depth of not less than 2m, the water depth of second or third stations should be more than 1m;

(4) The instrument should not to stay in the river when is turned on;

(5) Suspension method of instrument should ensure that equipment being flows into the pipe mouth;

(6) Instruments sample volume and instrument-like water tank or holding container volume ratio should be less than 0.9; found that when the apparatus filled with water samples to be set aside re-take.

Measuring the work of deep-sand accumulation, says: layout of vertical speed and the measured sand at each vertical line on the pitch and play facilities measure water depth, velocity measured on the vertical speed,vertical line in the sand to take test water samples, measuring vertical sand should be coincident with the vertical velocity [1]. As shown in Figure 2.

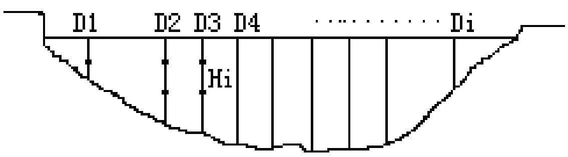


Figure 2. Vertical distribution of the river cross-section diagram

Vertical cross-section layout of sand should be based on the law of lateral distribution of sediment laid, under normal circumstances, the distribution should be roughly uniform, the Hong dense, sparse on both sides in order to be able to control the lateral variation in sediment turning point, the correct determination of section of sediment transport rate. Measuring the number of vertical sand generally should be based on test data analysis to determine: a class of not less than 10 points, second-class station no less than seven, three points less than three[3]. Plot when the sampler controls the proportion of sampling took place is shown in table 1.

We can see from Table 1,using 5-point method measurement sand the work process as follows: the whole river into the water, relative to the water level and river 0.2,0.6,0.8 Department, through the hydrological cableway will surge when the plot were sampled sampler , which corresponds to sampling time t/10, 3t/10, 3t/10, 2t/10 and t/10, according to hydrological regulatory requirements, sample bottles shall be filled.

TABLE I. WHEN THE PLOT TOOK PLACE SAMPLER SAMPLING THE PROPORTION OF COMPARISON TABLE

Sampling method	Sampling location					Notes
	Watersur face	0.2	0.6	0.8	River bottom	
	The sampling duration of the measuring point					
Two-point method		T/2		T/2		This the total duration of perpendicular sampling
Three-point method		T/3	T/3	T/3		
Ftve-point method	T/10	3t/10	3t/10	2t/10	T/10	

B. Measurement Method Based on Image Design

From the above analysis we can see, the whole water samples sampling time t/10, 3t/10, 3t/10, 2t/10 and t/10, derived from water samples for the entire sample volume (V) can also be divided into V/10, 3V/10, 3V/10, 2V/10 and V/10. Water sample volume distribution of its income as shown in Figure 3.

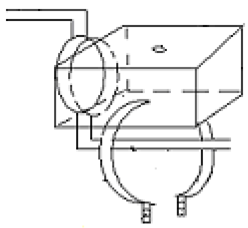


Figure 3. five-point method in water volume distribution diagram of

Hydrological stations commonly used sample bottle volume of 2400mL, its inlet diameter(γ) is 3-5mm, that when the sampling time t is fixed, we pass the current location of the measured flow rate V s, respectively, you can find the corresponding point of each water sample collected volume, according to hydrological requirements[3], river flow rate is calculated as follows:

$$V_s = \frac{KN}{T} + C = \frac{K \cdot na}{T} + C \tag{1}$$

V_s is the measured flow times the average velocity, in units of (m / s); K for the hydraulic pitch blades; T is the measured flow duration, in units of (s); C is a constant flow rate instrument; N for T periods of rotation of rotor, that is, the signal number; n for the signal number; a is the turn number for each signal. For a certain flow meter, values of K, C, a are known constants, measurements only measure N and T, or know n and T, you can calculate the velocity.

According to the formula (1), the volume of water sample for each point V' is:

$$V' = V_s T \pi (\gamma / 2)^2 L \qquad (2)$$

Where, T respectively, t/10, 3t/10, 3t/10, 2t/10 and t/10; L is the length of the inlet.

We will bottle underwater observation device designed to work with its high inlet diameter (h) in line at the bottom of the radius (r) and the plot of the cylinder when the same sample bottle, its volume (V'') Calculated as follows:

$$V'' = \pi (\gamma / 2)^2 h \qquad (3)$$

Among them, height of the observing bottle is equal with the inlet aperture(γ)for ensuring the minimal overlap of sediment particles in the observation bottle.

By the formula 2 and 3 have the camera right at all sampling points the number of sheets required intake of the image:

$$N = V' / V'' \qquad (4)$$

N is the number of sheets for the camera. In other words, image-based method of river sediment concentration is measured through the sampling volume of water sample (V) of continuous sections, which collect water samples.

However, these biopsies obtained images, it contains only two-dimensional image information of sediment particles, we must also measure the volume of sediment particle equivalent spherical degree as well as the density of critical data, and then the image of the proceeds go to noise, split calculate the projection of sediment particles in the pixel area ratio, area ratio can be calculated through the amount of sediment obtained, and then obtained its size, the last multiplied by its density in order to estimate the entire content of the river sediment.

IV. EQUIVALENT AND DENSITY OF SEDIMENT PARTICLE SIZE MEASUREMENT

A. Measurement of shape and size of sediment

River sediment particles are irregular objects, its area and volume measurements are very complex and we have collected from the river sediment was the image are discrete two-dimensional image. If the adoption of two-dimensional images into three-dimensional image, we first need the same goal of continuous video, and the conversion formula is very complex, and therefore does not apply to this method.

In engineering, for irregular shaped objects, measuring particle size usually take the equivalent diameter of an object, that is, the average size of an object obtained [16]. The average aim is a simple way to value a group of individual representatives, to measure the whole, which average must be a representative of a set of values, and all should be tended to concentrate on the average values. So the method is simple to calculate the advantages of convenience, so we adopt the method for measuring the volume of sediment particles.

According to hydrological specification, we meet the required random sample of sediment particles, sand particles for each 100 call it with the electronic balance weight, said 10 groups by their grain weight. At random in every 100 were obtained from 10 using vernier caliper to measure the three vertical dimensions: length (A), width (B), thick (C), usually A> B> C.

Length, width, thickness of the geometry is defined as follows[16]:

Thickness (C) is the distance between two parallel planes, the two tangent planes and particle two opposites, one of which should have the greatest stability;

Width (B) is another distance between pairs of parallel planes, the pairs of parallel planes and perpendicular to the plane parallel to determine the thickness of the intersection, and with two opposite edges of particles tangent;

Length (A) is another one-sided distance between pairs of parallel, this parallel plane sides with determine the thickness and width of the two parallel perpendicular to the intersection, and with the corresponding two particle cut physiognomy.

Equivalent volume diameter, equivalent diameter, quality, equivalent diameter, Stokes equivalent diameter, we have adopted is the volume equivalent diameter.

If the sediment particles as spheroidal, then its volume is:

$$V = \frac{\pi ABC}{6} = \frac{\pi d^3}{6} \qquad (5)$$

According to the formula 5, the volume equivalent diameter d as follows:

$$d = \sqrt[3]{ABC} \qquad (6)$$

In order to better express the shape of sediment particles, but also to analyze sediment particle sphericity. Particle sphericity is defined as: the volume of the spherical particles have the same surface area divided by the particle surface area, the calculation formula is:

$$\phi = \frac{\pi (6V / \pi)^{2/3}}{S} \qquad (7)$$

Where: V is particle volume, S is surface area of particles. Sediment particle surface area S, calculated as follows:

$$S = 2\pi \sqrt{A^2B^2 + B^2C^2 + C^2A^2 + (A^2BC + AB^2C + ABC^2)/3} \qquad (8)$$

According to the formula 5 to 8, 10 groups of sediment particles, the average equivalent diameter and sphericity measurement results in Table 2.

According to Table 2 the measured data, if the 10 sets of data of equivalent diameter and sphericity seeking once again, on average, and will obtain the equivalent average diameter (d'), And the average sphericity (ϕ') for all images of sediment particles in the fundamental factors, there are:

$$N' = \frac{S'}{\pi(d'/2)^2} \quad (9)$$

$$V' = N'\phi' \frac{\pi(d')^3}{6} \quad (10)$$

For N' is the sediment particle number in single image; For V' is the total volume of sediment particles in single image.

TABLE II. SEDIMENT PARTICLE EQUIVALENT DIAMETER AND SPHERICITY

Group Number	Three-axis dimensions (mm)			Equivalent diameter (mm)	Sphericity
	Length (A)	Width (B)	Thickness (C)		(ϕ)
1	0.083	0.069	0.047	0.065	0.9682
2	0.78	0.064	0.037	0.053	0.9475
3	0.061	0.034	0.027	0.042	0.9556
4	0.089	0.065	0.048	0.064	0.9317
5	0.076	0.063	0.042	0.061	0.9481
6	0.088	0.068	0.052	0.067	0.9637
7	0.075	0.061	0.049	0.059	0.9727
8	0.052	0.031	0.028	0.036	0.9133
9	0.068	0.042	0.035	0.044	0.9457
10	0.092	0.076	0.054	0.072	0.9765

B. Determination of sediment particle density

References pointed out that the sediment density and the vertical line at different locations on the particle size distribution of silt has nothing to do with the sediment there is no significant relationship between; from upstream to downstream, sediment density, a slight change along the annual inter-stable. So, for a particular river, just under the hydrology specification requires that the river sediment, after the required measurements, you can determine the average density of sediment particles.Sediment particle density measurement methods should be carried out in accordance with the following requirements [3]:

(1) The proportion with the 100ml bottle, ask the sand weight 15-20g;

(2)The precipitation will be concentrated in the proportion of the sample with a small funnel into the bottle, bottle of muddy liquid volume should not exceed the proportion of 2 / 3;

(3)Will be installed a good proportion of the sample bottle on the sand bath pot (or capped with a layer of sand placed in the iron furnace on the boil), turning from time to time the proportion of bottles, after cooling to room temperature after 15min;

(4)The proportion of slowly injected with water bottles, so that the water reach the right height, insert the cork, the bottle there is no air bubbles, and then plug the top hand wipe the water dry with a towel, bottle, saying that heavy muddy water bottle plus, after pulling out the rapid determination of cork bottle water temperature;

(5)After weighing the muddy water into the beaker of known weight, the placed sand on the steam bath pan with water inflow to the free flow of oven at 100 ℃ - 110 ℃ baking under the 4-8h, moved to dryer cooling to After the weighing room temperature, accurate to 0.001g.

(6)Each sand sample to be measured parallel to twice the density difference of no more than access to 0.02g, averaged.

The sediment particle density as follows:

$$\rho_s = \frac{W_S \rho_\omega}{W_S + W_\omega - W_{\omega S}} \quad (11)$$

Of which: ρ_s is the sediment density (g/cm3); ρ_ω is the density of pure water (g/cm3); W_S is weight of sediment (g); $W_{\omega S}$ is muddy water plus bottles weight (g); W_ω is Plus for the bottle and the weight of pure water (g).

When the water temperature setting 4 ℃, in accordance with the above steps on the stars of the 10 groups of sediment grain density measurements, the results shown in Table 3.

We calculate the average (ρ')of the 10 groups sediment particle density in Table 3, And that the average quality of the calculation for the sediment particles, there are:

$$W = \rho' V \quad (12)$$

One, V for all images of sediment particle size and measured.

TABLE III. SEDIMENT DENSITY MEASUREMENT

(Temperature = 4 ℃ ρ_ω = 0.99699g/cm ^{3})

Group Number	Sediment weight (g)	bottle weight Add muddy water(g)	Bottle weight add pure water (g)	Density(g/cm ^{3})
1	17.8	126.2	112.4	2.37
2	15.3	95.5	94.6	2.43
3	10.2	118.0	117.3	2.91
4	16.1	119.5	110.2	2.36
5	15.5	117.3	108.9	2.18
6	13.3	128.6	120.1	2.72
7	17.6	129.0	117.9	2.68
8	12.5	102.7	95.5	2.33
9	11.4	118.4	111.1	2.75
10	14.5	127.5	119.0	2.38

V. IMAGE PROCESSING

For the river sediment collected images for various reasons will be subject to a certain degree of interference and damage, so that the image contains a known noise signal. Therefore we have to be de-noising of image segmentation should be preceded by processing.

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VI. IMAGE PROCESSING

For the river sediment collected images for various reasons will be subject to a certain degree of interference and damage, so that the image contains a known noise signal. Therefore we have to be de-noising of image segmentation should be preceded by processing.

Noise can be understood as " interfere with the meaning of people from sense organs on the received information to understand the factors that source." For example, a black&white picture, the plane brightness distribution is assumed somehow, then the receiver from the interference of their brightness distribution can be called image noise. Noise of active black&white image and color television image noise can be expressed in some way. However, the noise in theory can be defined as "unpredictable, can only use statistical methods to understand the probability of random error." It is appropriate that the image noise is a multidimensional random process, therefore, random process description can be borrowed to describe the noise, which uses the probability distribution function and probability density function. However, in many cases, this description is very complicated, even impossible. The practical application is often unnecessary. Usually with their digital characteristics, namely mean and variance, correlation functions. For the characteristics of these figures can be reflected in some aspects of the noise.

A. Image Denoising

Riparian workstation computer processing the images to be collected by the camera. Each image pixel for 480 × 720. The purpose of image processing is to separate particles and background to obtain the projection area ratio data. To fix lighting conditions and the impact of noise on image quality, easy to carry out image segmentation basis, the need for image enhancement that is needed by selecting the appropriate method to remove noise.

We use shadow algorithm to reduce background noise difference: first observations collected a water sample bottle is not loaded when the static background image, as shown in Figure 4, the image contains the camera and light source to bring the noise and the observation bottles of images; followed by acquisition water flow in the pipe when the dynamic image, as shown in Figure 5; shadow algorithm using differential dynamic images for every one minus the static background image, so you can get rid of some of the first brought by the camera and light source noise and pipe images. Process the results shown in Figure 6.

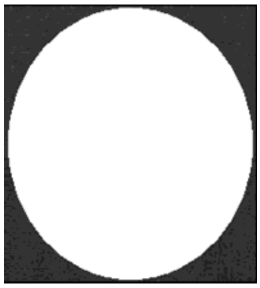


Figure 4. background image

Figure 5. river silt collection computer receives the image

Figure 6. sediment image after denoising

B. Image Segmentation

Image segmentation is an important imaging technology, the theoretical research and practical applications have been widespread attention. There are many types in image segmentation method, some segmentation algorithm can be directly applied to any image, while others apply only to specific categories of images. Some algorithms need to be rough image segmentation, because information needs to be extracted from the image. For example, you can set the image's gray level threshold method of segmentation. It is noteworthy that, not only the standard segmentation. Many different types of image or scene can be divided as the image data, different types of images, has its corresponding segmentation method segmentation, the same time, some of the segmentation method is only suitable for certain specific types of image segmentation. The quality of segmentation results is depending on the specific needs and requirements of the occasion to measure. Image segmentation is a key step from image processing to the image analysis, it can be said that the results of image segmentation have a direct impact on the image understanding.

Thresholding is the most commonly used region-based image segmentation method, the threshold is used to distinguish between different target gray value. If the image only the target and background two categories, then simply select a threshold value called the single-threshold segmentation, this method is the image gray value of each pixel compared with the threshold value, gray value greater than the threshold pixel value as a category is less than the threshold gray value of pixels of another. If the image has multiple targets, you need to select more than one threshold value will be separated from each goal, this method is called multi-threshold segmentation. Threshold can be divided into global threshold, local threshold and dynamic threshold. Threshold segmentation result depends on the threshold selection, from complex background to distinguish targets and their shape completely extracted, the threshold choice is a critical threshold segmentation. Thresholding is essentially derived in accordance with certain criteria for the optimal threshold process. Commonly used global threshold selection method using the image histogram of the peak and valley method, the minimum error method, the largest between-class variance method, maximum entropy auto-threshold value method and other methods.

In this paper, the Otsu thresholding method is used for image segmentation[6]. Otsu (Maximum Classes Square Error) method is considered optimal threshold selection methods. Otsu law is an adaptive threshold established methodology, also known as big-law, referred to Otsu. It is based on image characteristics of the gray image can be divided into the background and objectives of Part 2. Set the image f (x, y) gray-scale range of G = [0, L-1], the probability of gray-scale appear Pi, the threshold value of t will be the image pixels are divided into C0 = [0, t], and C1 = [t +1, L-1]. The probability of two types:

$$\omega_0 = \sum_{i=0}^{t} p_i \qquad (13)$$

$$\omega 1 = 1 - \omega_0 \qquad (14)$$

The probabilities of two types are:

$$\mu_0 = \sum_{i=0}^{t} \frac{ip_i}{\omega_0} = \frac{\mu_t}{\omega_0} \qquad (15)$$

$$\mu_1 = \sum_{i=t+1}^{L-1} \frac{ip_i}{\omega_1} = \frac{\mu - \mu_i}{1-\omega_0} \qquad (16)$$

Of which: $\mu = \sum_{i=0}^{L-1} ip_i$, $\mu_t = \sum_{i=0}^{t} ip_i$ .Criterion function is defined as the two major categories of inter-class variance:

$$\sigma^2(t) = \omega_0(\mu_0 - \mu)^2 + \omega_1(\mu_1 - \mu)^2 = \omega_0\omega_1(\mu_0 - \mu_1)^2$$

(17)

Take $\sigma^2(t)$ to maximum t, is the segmentation target and the best threshold of background T.

By Otsu (Maximum Classes Square Error) threshold segmentation method of Figure 6, the segmented image as shown in Figure 7.

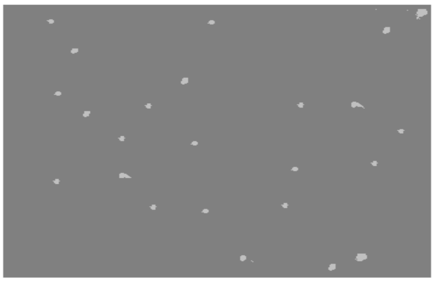


Figure 7. The segmented image

VII. ANALYSIS OF TEST RESULT

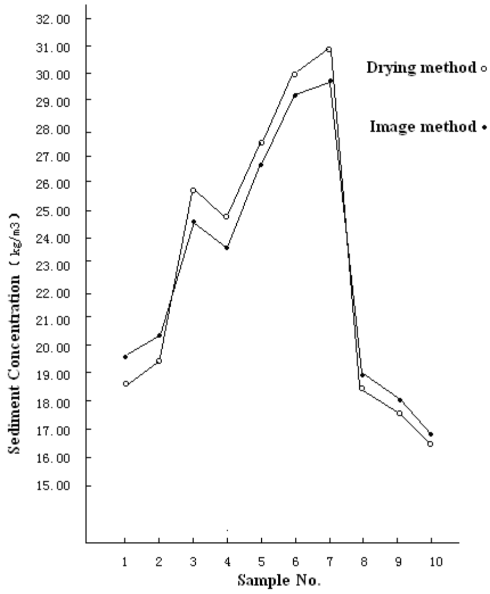
Silt content test study is to analyze the volume of silt sediment particle equivalent spherical degree, sediment density and sampling time and other related factors.

We set the sample bottles of water for 5 minutes, into the pipe diameter 5mm, length 20mm, the average equivalent volume (d') is 0.0563mm , mean sphericity (ϕ')is 0.9523, the average sediment density ρ' is 2.73g/cm3, in Ji'an Wu River Station we sample 10 times used 5-point sampling method to measure, and each time using the image method measurements are with the backlog to be synchronized sampling bottle sampler, the measurement results in Table 4.

From Table 4 we can see that during the flood season in July -9 months, due to increased water turbidity, increased content of silt, sediment particles overlap more, resulting in image measurement of the silt content is lower than drying method; while the dry season, due to lower content of river sediment, sediment was relatively little overlap, the image measurement of the sediment were higher than drying method. As the image method and drying method were obtained by sampling the water samples were not perfectly aligned, so two methods of error of 5% -1.5% for (except for the first time the initial measurement) is reasonable. Two kinds of methods to measure the relationship between the data shown in Figure 9.

Table 4 image method and drying method measurement data

Sample No.	Measured Time (2009)	Image method (kg / m 3)	Drying method (kg / m 3)	Error
1	February 7 15: 30-16: 00	19. 65	18.54	6%
2	March 10 9: 00-9: 35	20.36	19.37	5.2%
3	July 23 8: 20-9: 00	24.58	25.80	5%
4	August 17 14: 20-15: 00	23.71	24.89	5%
5	August 22 6: 40-7: 28	26.76	27.81	3.7%
6	September 16 7: 55-8: 30	29.36	30.25	2.9%
7	October 11 14: 25-15: 10	29.96	31.03	3.6%
8	November 20 17: 30-18: 30	19.05	18.66	2.1%
9	December 9 8: 55-9: 40	17.91	17.63	1.6%
10	December 22 11: 00-12: 00	16.85	16.54	1.9%



~~Figure 8.~~ The measured data between image method and drying method

VIII. SUMMARY

This paper presents an image measurement method is sand hydrologic and sediment data measurement in a new method applied to the lower sediment concentration (30kg/m^3) of river sediment measurement, research and development of this article is based on the actual Ji'an Hydrographic Office based on application requirements, and the city of Wujiang River Hydrometric Ji'an practical application, the application results show that the method than the traditional method of drying time reduced 96% accuracy compared with the drying method error of 1% - % 5, in line with norms of hydrologic and sediment measurements.But as a new approach to move towards maturity, the application must go through the test of time, continue to improve and improve..

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