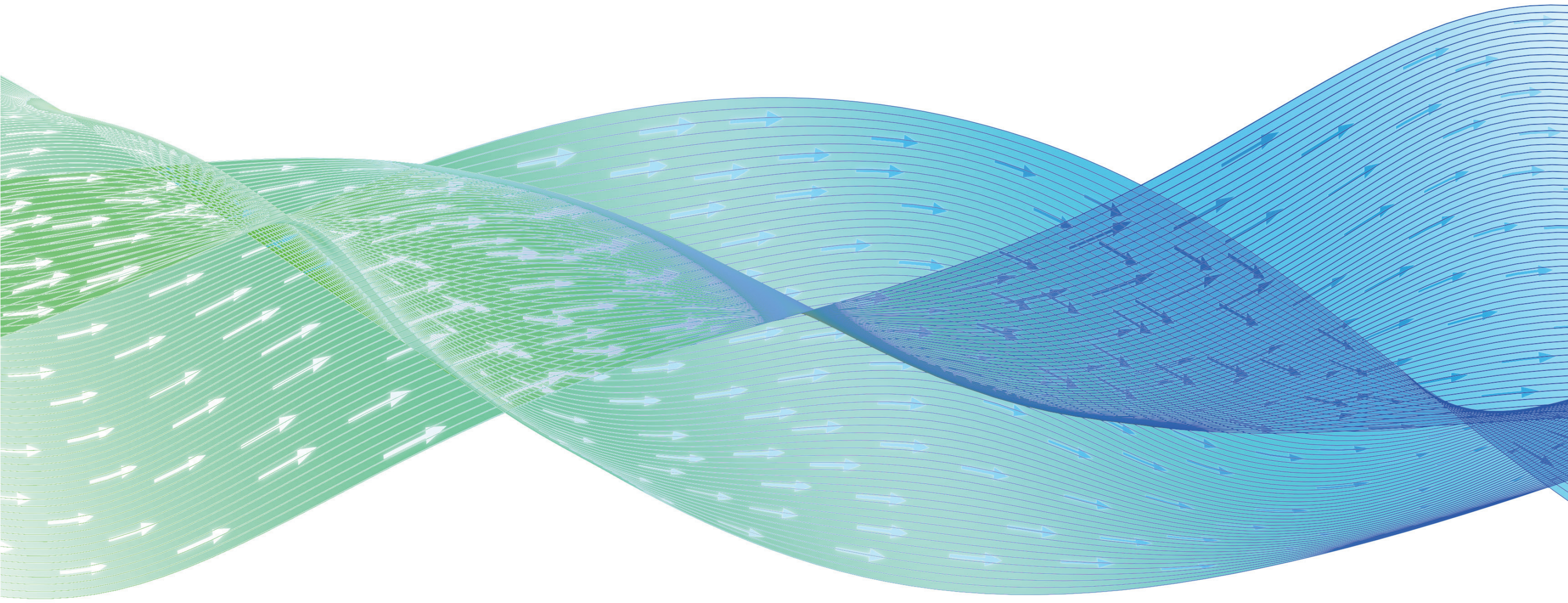
Hydro-STIV

Measurement software

Flow Velocity and Rate Using Video Footage

Safe, Accurate, New Flow Measurement

Based on the latest STIV Technology by Professor Emeritus Ichiro Fujita, Kobe University[*1]
The only commercial system loaded with STIV[*2]

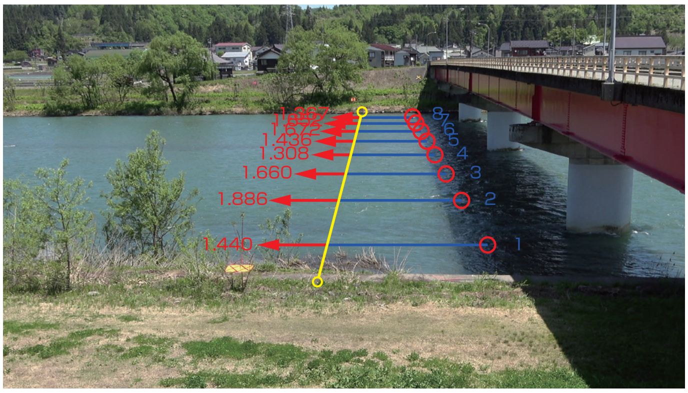


Hydro Technology Institute Co., Ltd.

[*1] Fujita I. Discharge Measurements of Snowmelt Flood by Space-Time Image Velocimetry during the Night Using Far-Infrared Camera. Water. 2017; 9(4):269.

[*2] As at September 2022

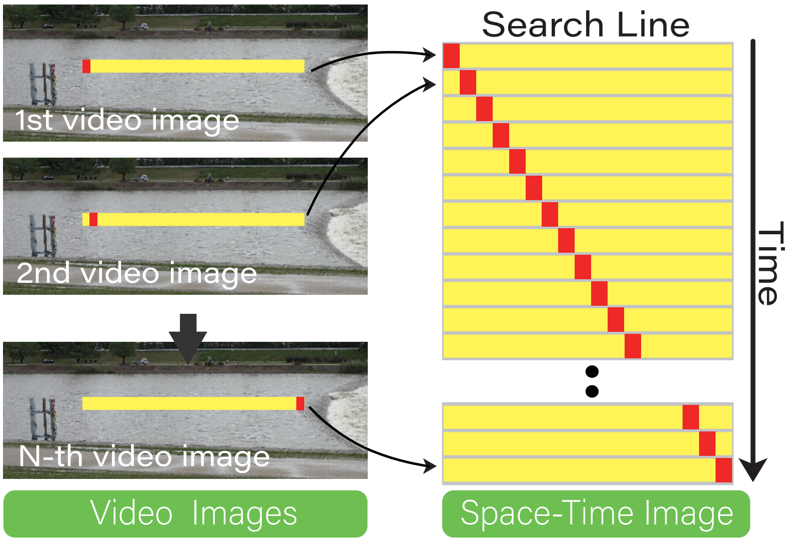
Flow Velocity Measurement Using Image



Hydro-STIV is a software which measures flow velocity and rate using video images and a water level.
High measurement accuracy is realized by the combination of the latest STIV technology and AI technology. Safe and easy measurement can be done even for flood without dangerous on-site work.

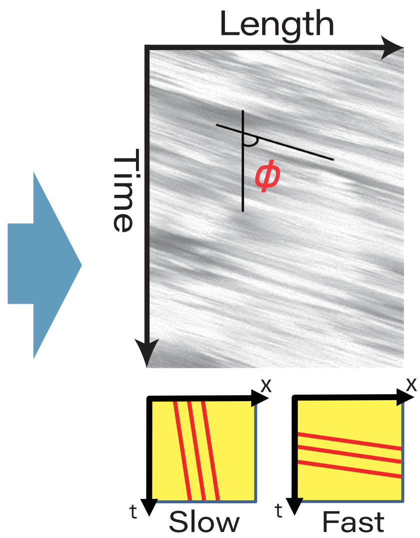
STIV overview

STIV creates STI(Space-Time Image : STI) from the video image and calculates flow velocity (V) from the STI. By taking the measured points of flow velocity from the river image frame by frame and arranging them vertically, an image(STI images) is generated in which a stripe pattern based on the flow velocity appears. Flow velocity can be measured by using that the slope of the stripe pattern represents the speed of the flow.



Generation of Space-Time Image(STI) from video images

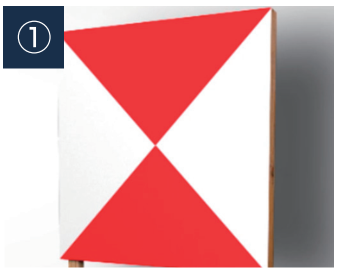
The yellow lines shows search lines, and the red squares show features of brightness value(surface ripples etc.). STI is generated by arranging the brightness values on the search line in the time direction, and the stripe pattern indicates velocity.



Calculation of Velocity(V) from STI

Velocity is calculated using slope of the stripe pattern(ϕ), length, and time of STI. When ϕ is small, velocity is slow(left-bottom), and vice versa(right-bottom).

Field Survey



Placing GCPs on both banks

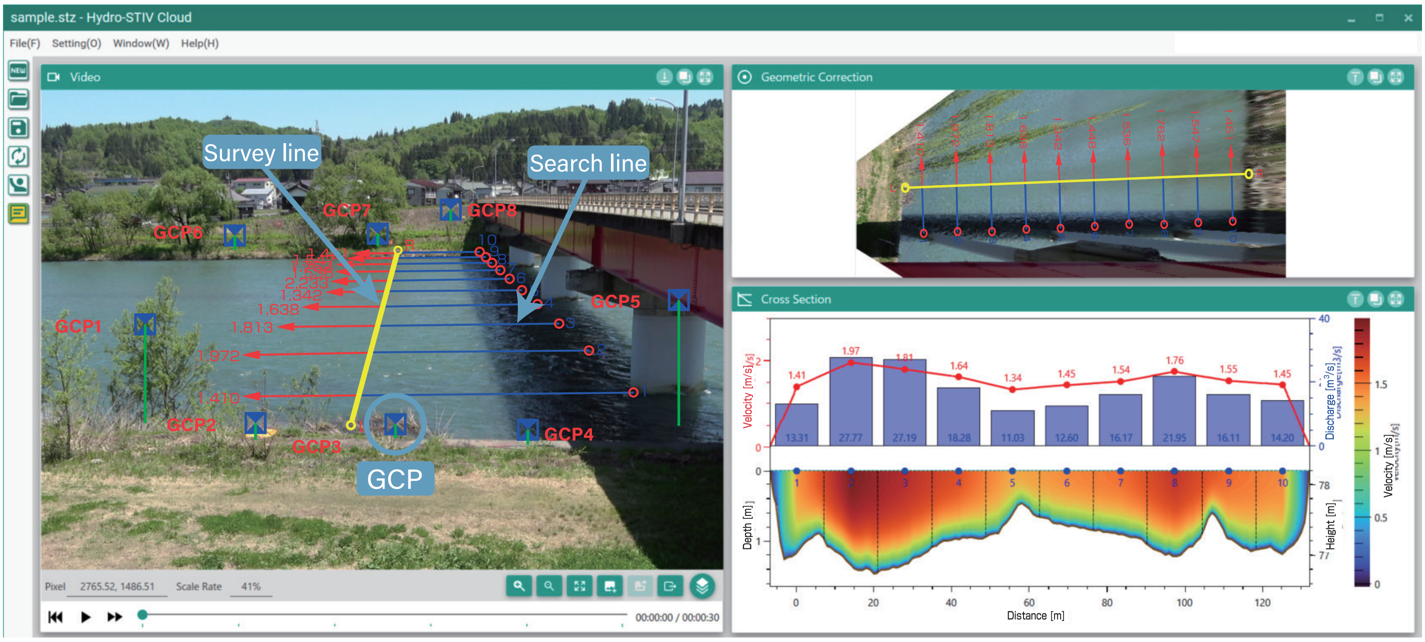
Surveying the coordinates of GCPs

Getting water level information

Shooting video

That is all for on-site work!

Measurement Using STIV

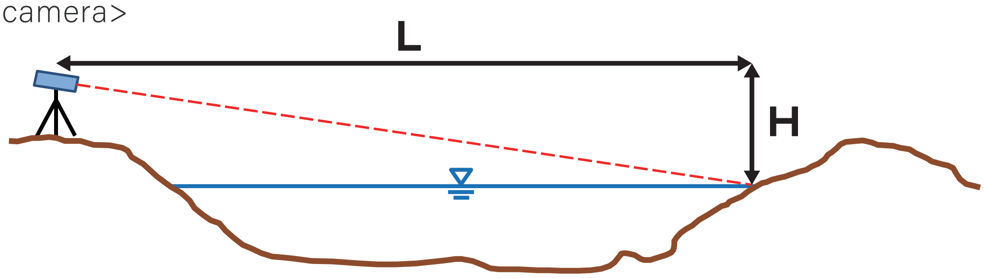


Wizard format enables easier measurement with an intuitive operation.
The measurement result can be output as an HTML and it can be used as a project report.

Example of Observation Camera Positioning

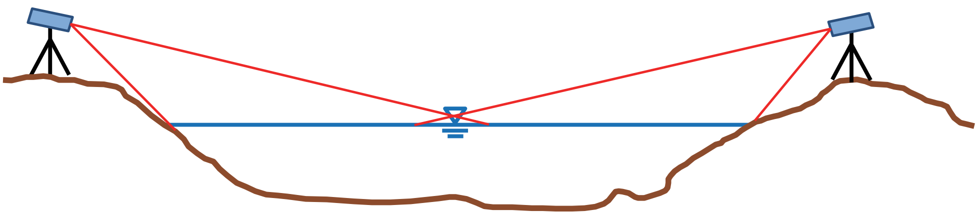
The figure shows examples of a camera positioning for observing flow velocity and discharge with Hydro-STIV. Please place the camera with reference to the following.

<Shooting with 1 camera>



Distance to the opposite bank : L	Height from water surface : H	Camera resolution
～50m	Any conditions	SD(720×480)
～100m	3m or higher	HD(1280×720)
～200m	7m or higher	FHD(1920×1080)

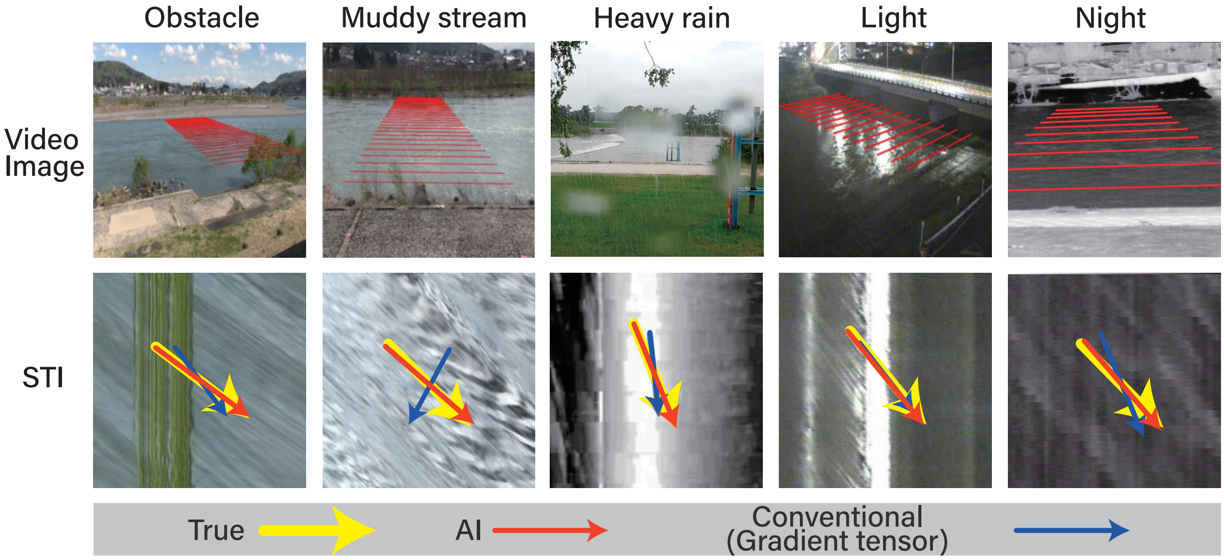
<Shooting with 2 cameras on both side of bank>



Distance to the opposite bank : L	Height from water surface : H	Camera resolution
～100m	Any conditions	SD(720×480)
～200m	3m	HD(1280×720)
～400m	7m	FHD(1920×1080)

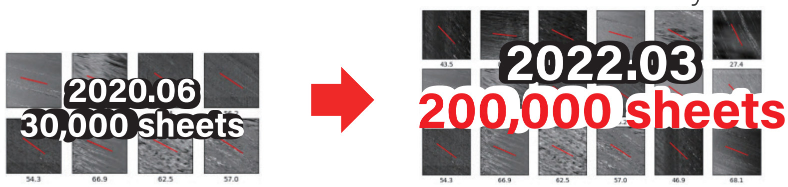
AI enables high-speed and high accuracy measurement

AI(Deep learning) enables more stable measurement than conventional methods. Highly accurate measurement can be performed with complete automatic analysis even when obstacles are in the image, when there is muddy water and heavy rain with high water, when there is a reflecting light at night, when an infrared camera is used.

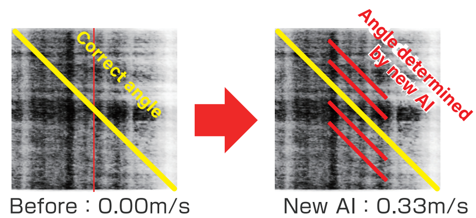


※Ichiro FUJITA, Tastushi SHIBANO, Kojiro TANI: Improvement of STIV for video images captured under deteriorated measurement conditions, JSCE, Ser. B1(Hydraulic Engineering),Vol. 74, No.5,I_619-I_624,2018.

AI has been trained by collecting actual river data continuously and improving learning data. As a result, even deteriorated STIs can be measured accurately.

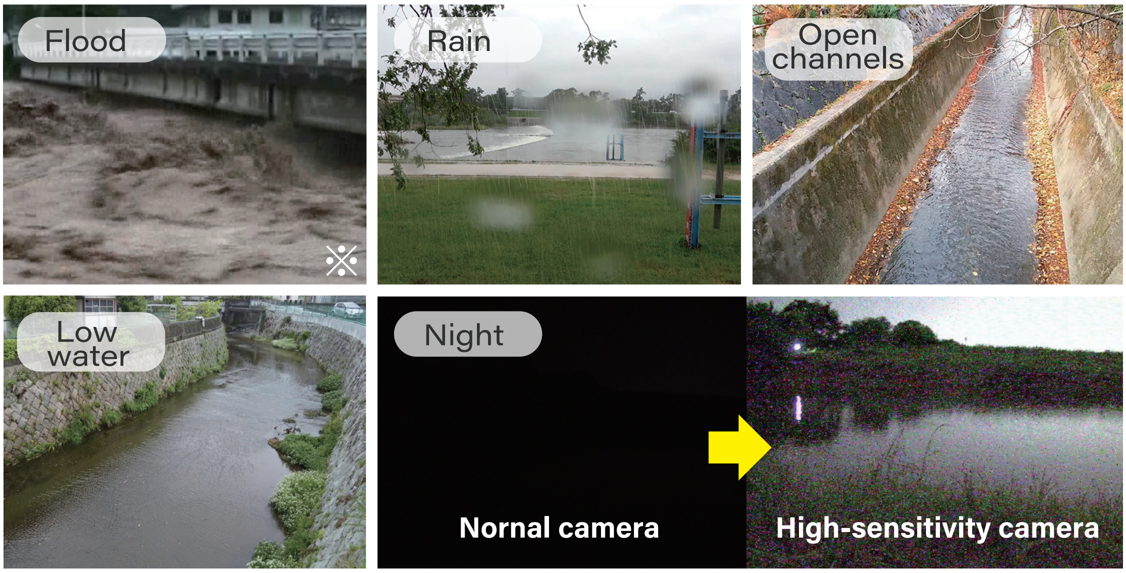


Deteriorated STIs that cannot be visually determined can be measured



The main features of STIV and applied examples

Unlike PTV, no tracer needed because STIV measures flow velocity from a subtle difference of the brightness. Measurement is available in various environment such as floods, low water.



※Created by processing data from GSI Japan(https://www.gsi.go.jp/BOUSAI/H29hukuoka_ooita-heavyrain.html)

Evaluation of STIV Measurement Accuracy

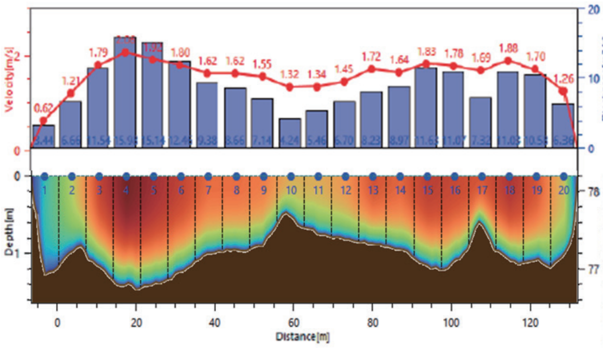
Comparison of measurement results using STIV and ADCP

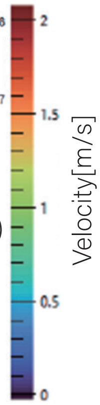
Comparison of flow velocity and discharge measurements by ADCP (Acoustic Doppler Current Profiler) and Hydro-STIV has confirmed that the measured discharge of the two differ within about 5%.

Hydro-STIV	ADCP
181.98m³/s ↔	182.35m³/s

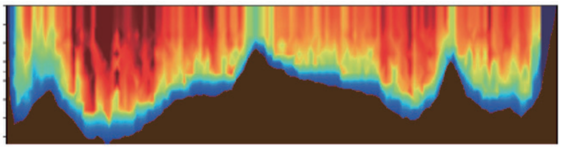
difference 0.2%

▶Velocity on the surface and distribution in cross section (Hydro-STIV)





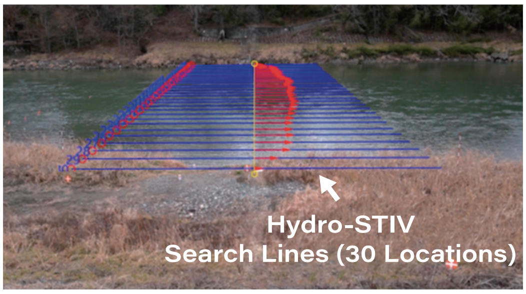
▶Velocity distribution in cross section(ADCP)



Measurement accuracy equivalent to ADCP

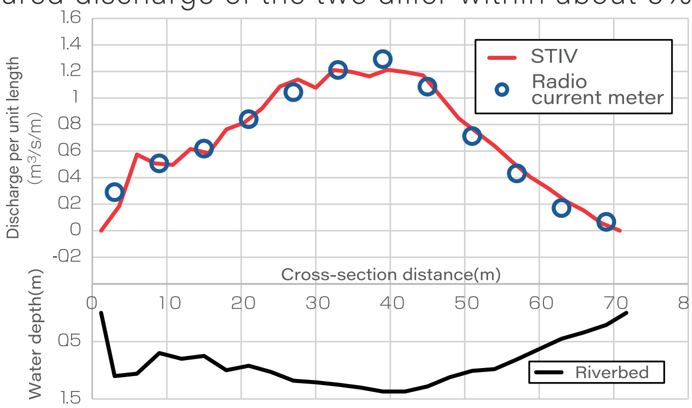
Comparison of measurement results using STIV and Radio current-meter

Comparison of flow velocity and discharge measurements by a Radio current-meter and Hydro-STIV has confirmed that the measured discharge of the two differ within about 5%.



Hydro-STIV	Radio Current-Meter
49.96m³/s ↔	49.25m³/s

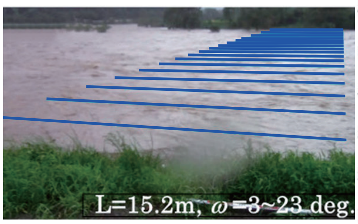
difference 1.4%

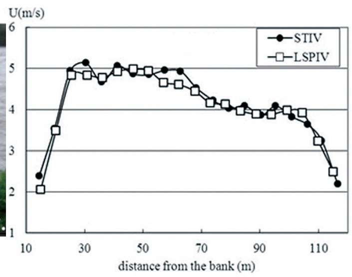


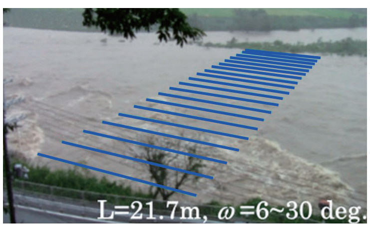
Measurement accuracy equivalent to Radio current-meters

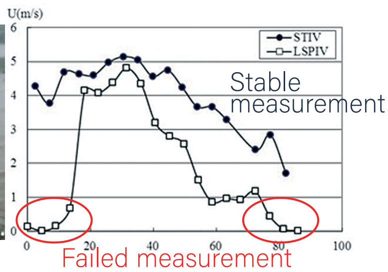
Comparison of measurement results using STIV and LSPIV(other image velocimetry)

In STIV, the flow velocity can be measured stably even if there are obstacles such as vegetation that are difficult to apply LSPIV or even if the clear ripple doesn' t appear on the image.









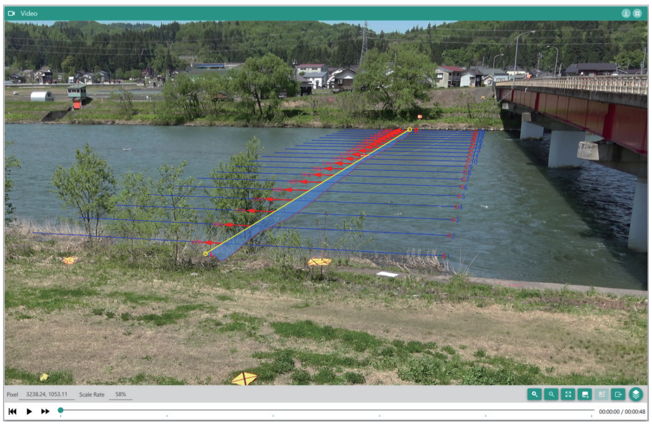
※Aberle, Jochen, et al., eds. Experimental Hydraulics: Methods, Instrumentation, Data Processing and Management: Volume II: Instrumentation and Measurement Techniques. CRC Press, 2017.

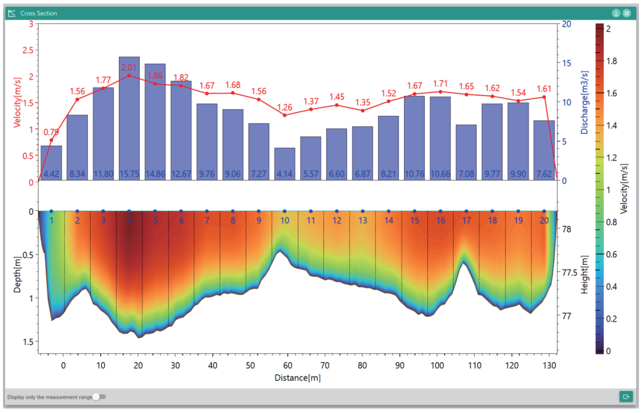
Stable measurement accuracy compared to other image velocimetry

Main Features of Hydro-STIV

Calculation of cross section velocity distribution by MEM(Maximum entropy Method)

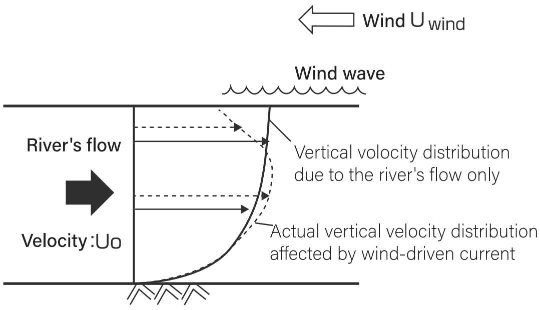
This feature estimates the cross section velocity distribution from the velocity distribution on the surface and the cross section profile. By using this feature, velocity can be calculated without the calibration factor. The estimated cross section velocity distribution is displayed in contour on the cross section image.





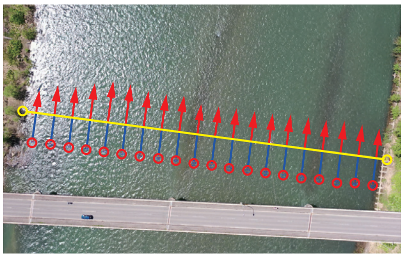
Wind effect correction

By using this feature to take into account the effects of wind direction and velocity, surface velocities can be calculated with correction for wind effects.
※The correction formula presented in the "Manual for Advances Flow Observations during High Water" of PUBLIC WORKS RESEARCH INSTITUTE, Japan.



Drone footages for measurement

Images taken from the sky by a drone or other devices can be used to measure the flow velocity and discharge. Rivers so wide that the opposite bank cannot be seen, mountainous areas that are difficult to access, or rivers during flood can be easily measured by drone footage. Another advantage of vertical shooting is that no geometric correction is required since the actual scale can be detected by the distance between only 2 points in the image.

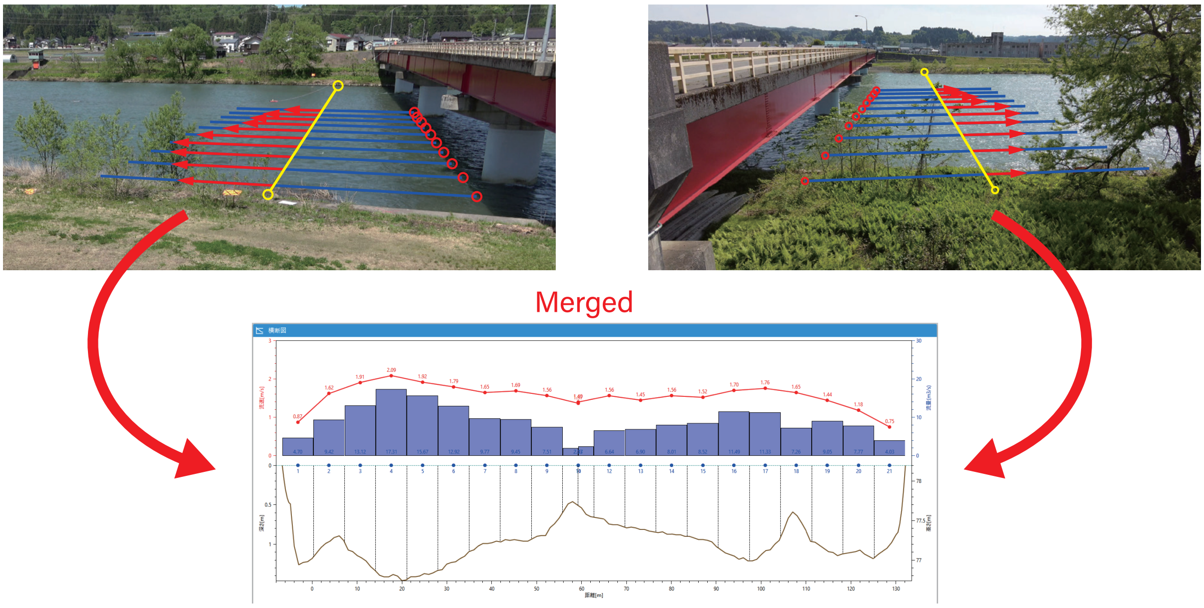


※1 Created by processing data from GSI Japan(https://www.gsi.go.jp/BOUSAI/H29hukuoka_ooita-heavyrain.html)
※2 Fujita I., Notoya Y. and Furuta T.:Measurement of inundating flow from a broken embankment by using video images shoot from a media helicopter,River Flow 2018.

Measurement in large rivers using multiple cameras

Large rivers can be measured by dividing the shooting range with multiple cameras.

<Taken from the left bank> <Taken from the right bank>



It is possible to customize a system that automatically performs measurement with multiple cameras.

▶Cameras on both banks

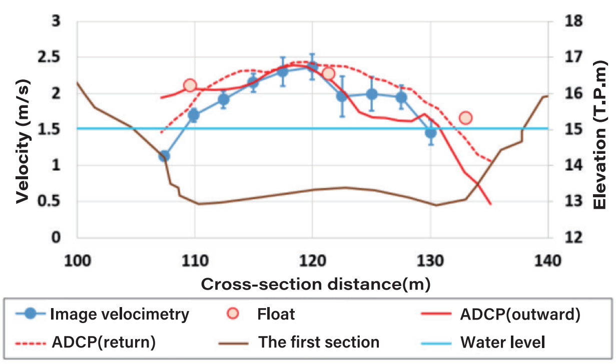
▶Multiple cameras on the bridge

▶Example of application when the entire width of the river is not visible due to vegetation, etc.

Uncertainty evaluation

Based on the uncertainity evaluation method specified by International Organization for Standardization(ISO), we have developed an uncertainity evaluation function for STIV measurement results.※

The uncertainity evaluation range of measurement results can be used to evaluate the validity of measurement conditions and to make rejection decisions on measurement results.



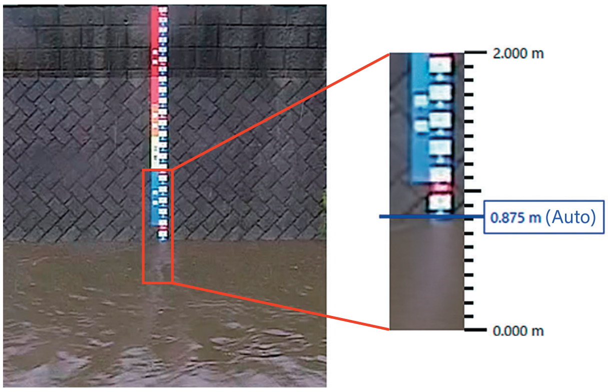
※ISO：ISO 25377 (Hydrometric uncertainty guidance (HUG)), 2020.

Paper from Hydrosoken, Watanabe et al., Uncertainty evaluation of STIV river flow measurement, Advances in River Engineering, Vol. 27, pp7-12, 2021.

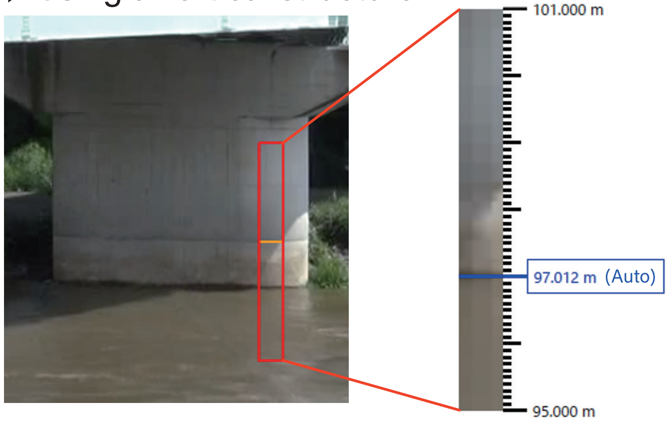
Automatic water level measurement using image

Detects water edge by vertical structures such as gauges, piers, concrete walls in image and measures water level. By using a gauge or surveying a verticle structure, the water level can be measured using Hydro-STIV only.

▶Using a gauge

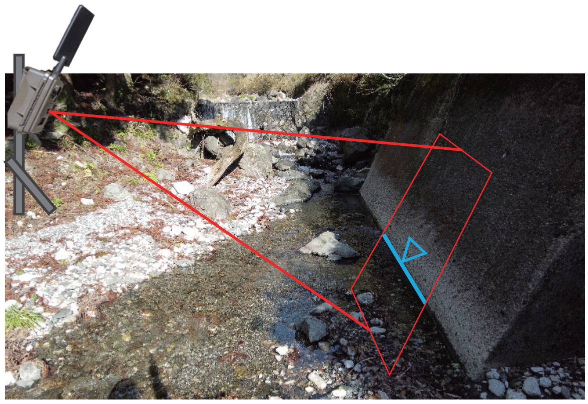


▶Using a vertical structure



Even for small rivers in mountainous areas, water level and flow velocity can be measured and flow observation can be performed by installing only a trail camera.

A camera which has communication function enables realtime flow observation using only itself.

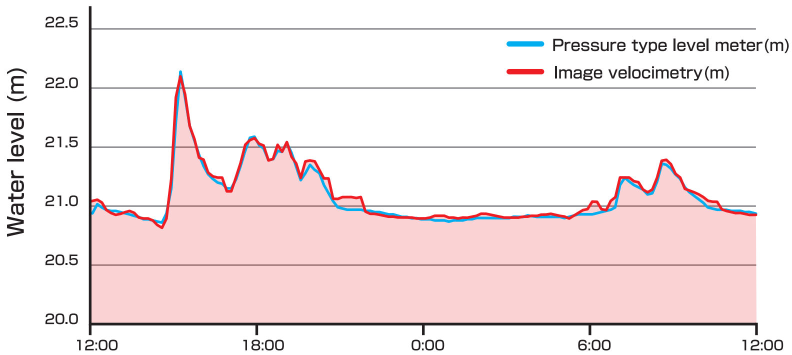


▶Accuracy of water level measurements

Measurement accuracy depends on the resolution of the image to be measured.
When measuring points with a resolution of 5 cm/pixel or less, this corresponds to performance Class 3 of water level measuring devices according to ISO standards.
(ISO4373:2008_Water level measuring devices)

Class	Resolution	Range	Uncertainty
Performance class 3	5cm	Height range 5.0m	≤±1 % of range

The water level measured by Hydro-STIV was compared with the water level measured by the Pressure type level meter. And it has been confirmed that the results by the Hydro-STIV follows that of Pressure type level meter.

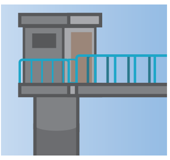


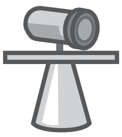
Introduction support & Contract analysis

Observation system introduction support

When introducing discharge observation using STIV by installing a new fixed camera or using existing CCTV, there are a wide range of items to consider, such as surveying the observation points and selecting the installation equipment.
We support our customers from the selection of observation points to operation, based on our experience in introducing the system to many sites across the country.

▶Observation site





- Review camera position and angle of view
- Camera performance check
- Planning for GCP Survey

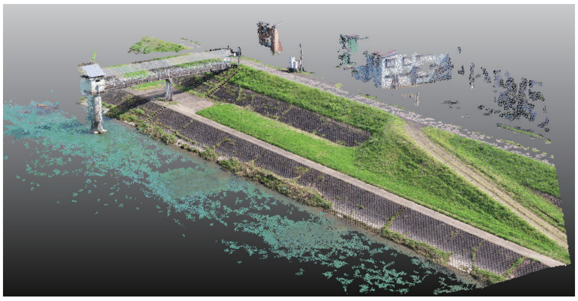
▶Server

Hydro-STIV
Real Time

- Server performance check
- Set-up of measurement condition
- Regular analysis of observation results

Geometric Correction Service(with SfM point cloud generation option)

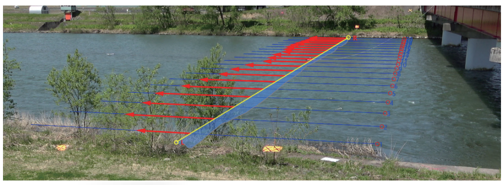
It is possible to review the location of the GCP and perform geometric correction using GCP. In addition, by utilizing the 3D point cloud from SfM, geometric correction can be performed without resurveying even when there are deficiencies in the surveyed GCPs or when the planned angle of view has changed.
If customers provide us with videos used to measure flow velocity and discharge, the coordinates of the GCP survey, and images of the surrounding area, SfM and geometric corrections can be performed.

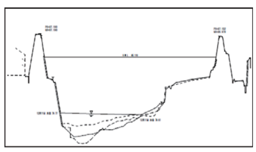


SfM(Structure from Motion): Technology to make objects and scenery in an image 3D by parallax between multiple images

STIV Contract Analysis

Our expert technicians analyze flow velocity and discharge from images using Hydro-STIV.
If customers provide us with river images, water level information, river channel cross section data, and GCP information taken in the field, we can create a report of the measurement results.





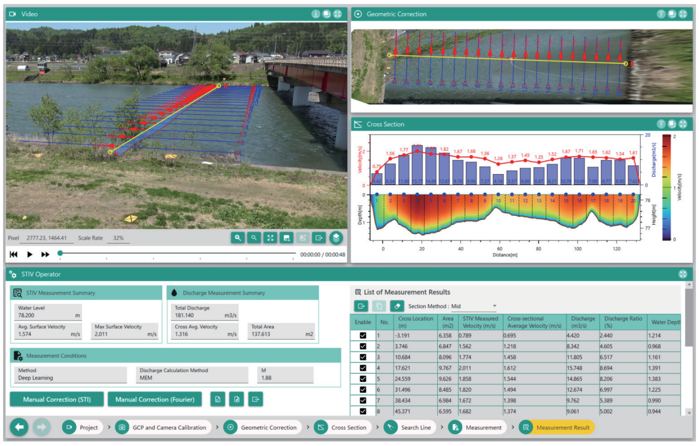
Hydro-STIV Cloud

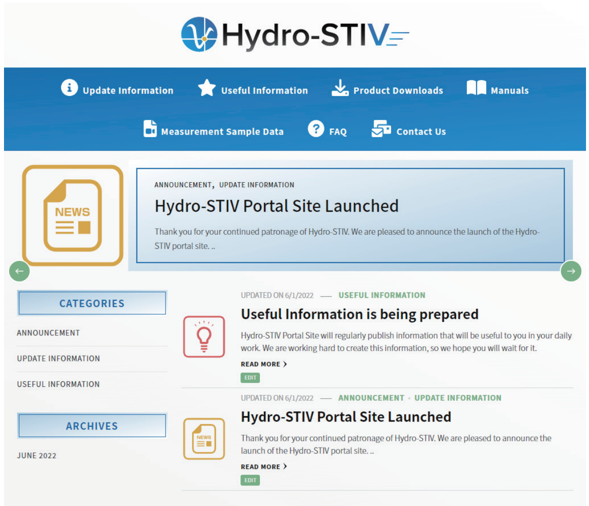
Flow velocity and discharge measurement software using video footage

Hydro-STIV Cloud uses network authentication via a cloud system, allowing it to be used not only on office PCs, but also at telework, observation sites, and any other location.

Information such as video data or measurement results are not used or stored on the network, the system can be used with confidence in terms of security.

In addition, Hydro-STIV Cloud customers will be provided with a portal site for software downloads and the latest information on Hydro-STIV.





Hydro-STIV Portable

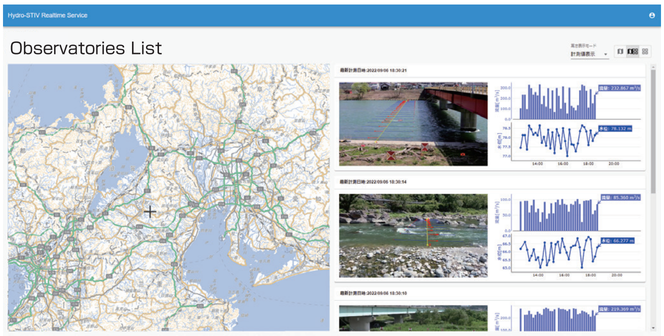
Flow velocity and discharge measurement device using video footage

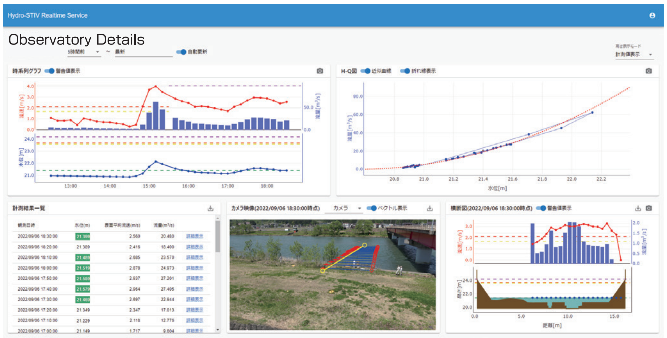
Hydro-STIV Portable is a measurement device that can record videos with a built-in camera in smartphone or tablet and perform velocity and discharge measurements on-site. The velocity and discharge can be measured using only angle information from the smartphone or tablet's accelerometer and distance to the water surface. It does not require surveying of GCPs and can easily measure flow velocity and discharge using distance between the two points.

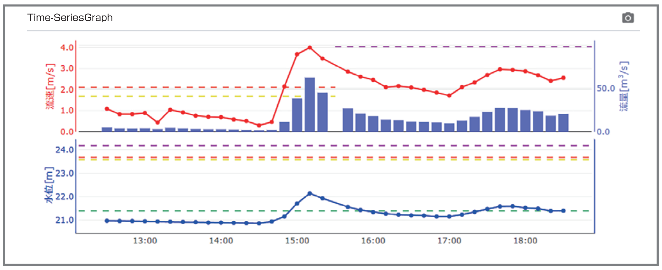
Hydro-STIV Real Time

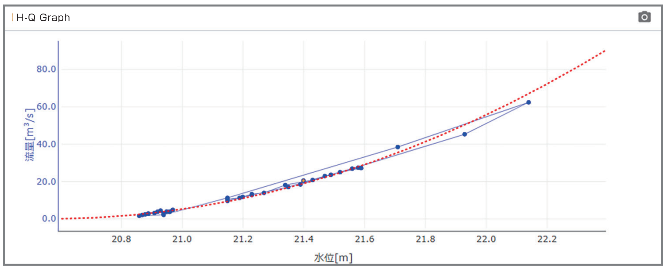
Automatic discharge observation system using video footage

Hydro-STIV Real Time is a system that automatically observe discharge using videos recorded by a camera and water level.
By installing the system on a server connected to a camera installed at the observation point, real-time discharge can be observed at all times.
This system includes processing of image and other data, and user interface.









Camera suitable for shooting videos for use with Hydro-STIV

▶CCTV camera, handy camera, smartphone camera

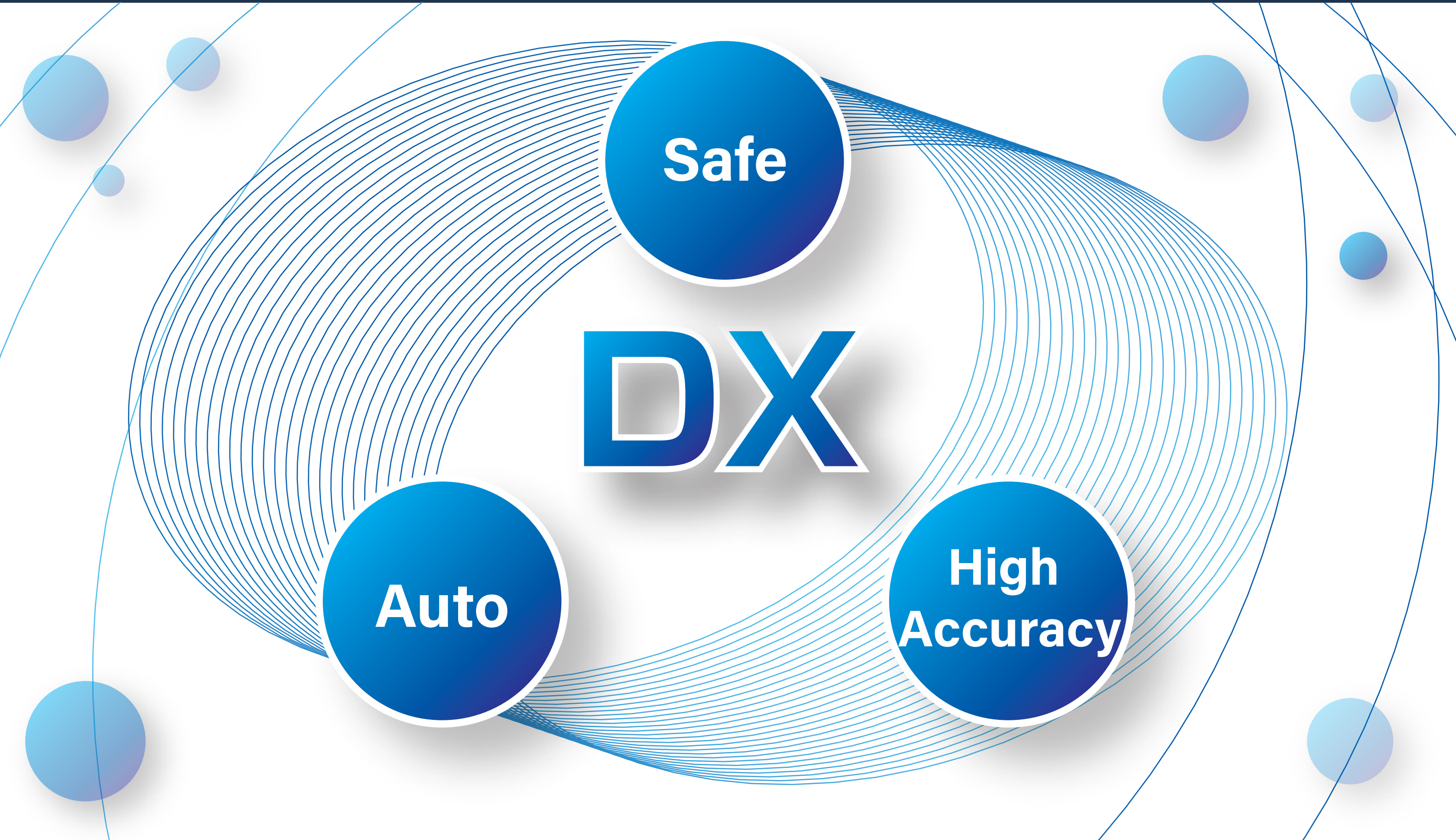
Any type of camera can measure flow velocity and discharge as long as it can capture even the slightest ripple on the surface. It is available with a standard visible light camera during the day, and it can be done at night if the light is properly positioned.

▶High-sensitivity camera

A high sensitivity camera that can observe at night is effective at hydrological observation points of rivers and other locations where accurate discharge observation is required at all times.
It is ideal for full-time observation using Hydro-STIV Realtime.

▶Trail camera

A trail camera costs low, and its communication function is useful in mountainous areas where regular camera installation is difficult due to power and communication problems.



Main functions

Measurement	● Flow velocity and discharge measurement by STIV
	● AI automation with high accuracy in velocity
	● Flow velocity measurement by PTV
	● Automatic water level measurement using image
	● Geometric correction of a fixed point shooting image
	● Discharge calculation by mensuration of division
	● Filtering of abnormal values in measurement
	● Wind effect correction
	● Discharge calculation by MEM
Utility	● Visualizing results across river cross section
	● Consecutive measurement at same angle of view
	● Manual correction of measurement results
	● Video stabilization
	● Video editing(cut out the target time section)
	● Result summary report output
	● KMZ coordinates output (Google Earth, etc.)
	● Batch output of related files

System requirement

<System requirement>	
O S	: Windows 10 (64-bit), Windows 11
C P U	: Intel Core i5 third generation or higher
Memory	: 4GB or more
Resolution	:1920×1080 (Display)
<Video requirement>	
Format	: avi, mp4, mov, wmv, m2ts
Scanning	: Progressive
Length	: 15˜30 Seconds (Recommended)
Frame rate	: 24fps or more (Recommended)
Resolution	: 720p, 1080p or more (Recommended)
*Camera lens without distortion is recommended	

【Introduction performance : Alphabetical order】

Japan Construction Engineering ResearchInstitute, Foundation of River&Basin Integrated Communications, Public Works Research Institute, Gifu Univ., Ishikawa Prefectural Univ., Kobe Univ., Kyoto Univ., Meijo Univ., Nagoya Univ., Okayama Univ., Osaka Univ., Univ. of Yamanashi, Chuden Engineering Consultants, FUJITSU, Fukuda Hydrologic Center, Hokkaisuiko Consultant Corporation, Kyusyukensetsu Consultant, Mitsui Consultants, NEWJEC, NTTDOCOMO, Pacific Consultants, TOKEN C.E.E. Consultants, Wesco Holdings

Overseas (Local government · Research Institute · Academic institute · Corporation)
Australia, Canada, Chile, China, Finland, France, Iceland, Indonesia, Ireland, New Zealand, Philippines, Republic of Korea, Sweden, UK, USA, Vietnam

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