Integration manual | BRC-X1000 series and BRC-X400 series

Camera Tracking function for AR/VR application

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CONTENTS

1. Overview

This document describes some technical details of ‘Camera Tracking’ function supported by BRC-X1000 series (BRC-X1000, BRC-H800 and BRC-H780) and BRC-X400 (BRC-X400 and BRC-X401) series software version 2.10 for the purpose of system integration. This is a function that a targeted camera – normally a remote controllable PTZ camera transmits its Pan, Tilt, Zoom and Focus position (hereafter it will be abbreviated as PTZF) position in a real-time manner so that the backend AR/VR solution can make CG overlay etc. into the captured video as if such CG objects were really existing.

2. Target models

The following models are applicable to the Camera Tracking function.

BRC-X1000 series:

BRC-X1000, BRC-H800, BRC-H780 (China only)

BRC -X400 series:

BRC-X400, BRC-X401 (China only)

3. Supported networking protocol (free-d protocol)

As a means of transmitting PTZF tracking metadata, we adopt to use ‘free-d’ protocol as this is widely used in the virtual studio solutions. The specification of the free-d protocol is described as part of the free-d installation manual (see Appendix A in the manual).

3.1. Supported communication physical layer and transport layer

Although the original free-d protocol assumes its physical communication layer as RS422/RS485 serial communication, we adopt to use the Ethernet-based physical layer (via RJ-45 [LAN] connector

in the rear panel of the camera). Since couple of the virtual studio solution providers already had some experience to use UDP/IP there, we also adopt to use it as a transport layer to transmit the metadata.

As for the port number of the UDP data transmission, we are supposed to give users such a choice. I.e. UDP port number can be configured within the reasonable range (e.g. 1025 to 65534).

3.2. Supported mode

Although the original free-d protocol specifies two modes of operation – stream mode and polled mode, we only adopt to support stream mode this time considering its less overhead and efficiency. As a result of only supporting stream mode, mode switching capability using D0 message will not be either supported.
In stream mode, D0 message specify its controlling capability of ‘Stop stream mode’ and ‘Start stream mode’ command. Considering this message definition, we adopt to support two types of stream mode of “always” and “ondemand” whose details go on below.

3.2.1. “always”

This is the mode that the camera keeps on transmitting metadata regardless of whether actual receivers receives such data or not. In case of a UDP data transmission, a remote peer of receiving such UDP data can signal whether any valid listener is present in the computer node using ICMP message. This “always” mode doesn’t care about whether they receive such ICMP message or not.

This mode should be also based on the configuration parameter of a remote IP address as a destination. So such configuration parameter is to be also provided.

3.2.2. “ondemand”

This is the mode that the camera will wait for the D0 ‘Start stream mode’ message to identify the remote peer to transmit the metadata. Once it receives the ‘Start stream mode’ message, the camera starts to send the metadata to the destination. The data transmission will be kept on until it receives the ICMP error message (destination unreachable message) or until it receives D0 ‘Stop stream mode’ message.

3.3. Supported message

As a result of the above mentioned specification, the following free-d messages are supported.

- D0 message: Only supports [00]: Stop stream mode, [01]: Start stream mode
- D1 message: The following data are to be filled in by the camera.
  - Camera Pan Angle
  - Camera Tilt Angle
  - Camera Zoom
  - Camera Focus
  - Iris F number - using Spare/User Defined [16 bits] fields

3.4. Supported metadata description

This section describes what kind of information is conveyed in the metadata stream as well as its data representation format.

3.4.1. Camera pan angle (bytes 2-4)

What are to be put into bytes 2-4 (3 bytes, <PH><PM><PL> fields in the free-d specification) is following the definition in Appendix B.2 Camera pan angle.
The value is expressed in degrees as a 24-bit twos-complement signed number, where the MSB bit (bit 23) is the sign bit, the next 8 bits (bits 22 to 15) are the integer part and the remaining bits (bits 14 to 0) are the fractional part.

3.4.2. Camera tilt angle (bytes 5-7)

What are to be put into bytes 5-7 (3 bytes, <TH><TM><TL> fields in the spec) is following the definition in Appendix B.3 Camera tilt angle.
Exactly the same as the above camera pan angle, the value is expressed in degrees as a 24-bit twos-complement signed number whose sign bit, integer part and fraction part are 1, 8, 15 bit(s) respectively.

3.4.3. Relationship between Image Flip setting and pan, tilt coordinate

Both BRC-X1000 series and BRC-X400 series have Image Flip setting where video output invert setting is performed according to its mount mode (either it is desktop mounted [off] or ceiling mounted [on]). Please be mindful that the above camera pan angle and tilt angle field representation adapts this Image Flip setting. I.e., regardless of the Image Flip setting, data representation of the

clockwise displacement is positive under the camera pan angle while data representation of up displacement is positive in the camera tilt angle.

3.4.4. Camera zoom (bytes 20-22)

Camera zoom position information is put into bytes 20-22 (3 bytes, <ZH><ZM><ZL> fields in the spec). Since the specification (Appendix B.8 in the free-d spec) doesn't specifically state about data representation format expect that the value should be expressed as a 24 bit positive unsigned number, we adopt the following value representation which is specified by the Sony VISCA protocol. For the details, see Table 1 and Table 2.

Table 1 : Zoom position value and Zoom ratio information for BRC-X1000 series (just for reference)

Zoom Position and Zoom Ratio (for reference)

Zoom Position zzzz value	Zoom Ratio
0000	×1
1800	×2
2340	×3
2A40	×4
2F00	×5
3300	×6
3600	×7
3880	×8
3AC0	×9
3CC0	×10
3E80	×11
4000	×12
5580	×18 (While using Clear Image Zoom)
6000	×24 (While using Clear Image Zoom)*1

Table 2 : Zoom position value and Zoom ratio information for BRC-X400 series (just for reference)

Parameter	Zoom ratio
0000	×1
0DC1	×2
186C	×3
2015	×4
2594	×5
29B7	×6
2CFB	×7
2FB0	×8
320C	×9
342D	×10
3608	×11
37AA	×12
391C	×13
3A66	×14
3B90	×15
3C9C	×16
3D91	×17
3E72	×18
3F40	×19
4000	×20
5556	×30 (While using Clear Image Zoom)
6000	×40 (While using Clear Image Zoom)

3.4.5. Camera focus (bytes 23-25)

Camera focus position information is put in bytes 23-25 (3 bytes, <FH><FM><FL> fields in the spec). Since the specification (Appendix B.9 in the free-d spec) doesn't specifically state about data representation format expect that the value should be expressed as a 24 bit positive unsigned number, we adopt the following value representation that is specified by the Sony VISCA protocol. For the details, see Table 3 and Table 4.

Table 3: Focus position value and Focus distance for BRC-X1000 series (just for reference)

Focus Ratio and Focus Distance (for reference)

Focus Ratio pppp value	Focus Distance
1000	∞
2000	5 m
3000	3 m
4000	2 m
5000	1.5 m
6000	1.2 m
7000	1.0 m
8000	0.8 m
9000	0.55 m
A000	0.35 m
B000	0.25 m
C000	0.18 m
D000	0.14 m
E000	0.1 m
F000	0.08 m

Table 4: Focus position value and Focus distance for BRC-X400 series (just for reference)

Parameter	Focus distance
1000	∞
2000	5 m
3000	3 m
4000	2 m
5000	1.5 m
6000	1.2 m
7000	1.0 m
8000	0.8 m
9000	0.6 m
A000	0.47 m
B000	0.35 m
C000	0.26 m
D000	0.17 m
E000	0.1 m
F000	0.08 m

3.4.6. IRIS F number and frame count (bytes 26-27)

We examined about whether there is another element of the metadata which would be useful to be put in conjunction with PTZF information. The IRIS information was identified as useful considering the virtual studio solution use case scenario. Using this value, the backend virtual studio solution provider may be able to compensate the brightness of the overlaid CG objects that will be suitable to the currently captured scene.

We adopt to put the IRIS information into the “Spare / User Defined (16 bits)” fields in <SH><SL>

part. The value is expressed as 12 bits positive unsigned number where 100 times (x100) of the F number is put here. E.g. the value of 0x0118 (=280d : <SH>=0x01, <SL>=0x18) should indicate the current F number is F2.8. Please be sure that the larger the number here is, the darker the lens IRIS gets to.

In addition to that, 4 bits of frame count (0 – 15) is also to be put in the upper 4 bits of <SH> field. This may be helpful to determine which video frame the tracking metadata packet should be associated with in case that those UDP packet arrival time fluctuates depending on network environments, processing load inside the camera etc..

4. free-d related CGI parameter configuration

In this chapter, some explanation about the Camera Tracking function (free-d) configuration parameters goes on below. In order to control various free-d related aspects, we adopt to make use of the existing camera's CGI system. You will also be able to control those CGI parameters using the built-in Web GUI.

4.1. Basic configuration scheme

This section explains about typical way of getting and setting the various configuration parameters which is related to this function using HTTP.

4.1.1. Getting the current configuration

The following HTTP URI is used for getting free-d related configuration parameters where you can use either way of Normal format or Java Script parameter format.

[Normal format]

http://<ip_address>/command/inquiry.cgi?inq=freedconfig

[Java Script parameter format]

http://<ip_address>/command/inquiry.cgi?inqjs=freedconfig

As for which HTTP method will be used in the above URI, GET method is only allowed. As for the authentication, it requires HTTP digest authentication (RFC 2167) along with the administrator privilege for the target camera.

4.1.2. Setting the current configuration

The following HTTP URI is used for setting free-d related configuration parameters.

http://<ip_address>/command/freedconfig.cgi?<parameter1>=<value1>[&<parameter2>=<value2>&...]

The URI path of "/command/freedconfig.cgi" is newly introduced for the Camera Tracking function. You will be able to concatenate what kind of parameter(s) you would like to configure by putting '&' followed by the conventional HTTP CGI Query string form (<parameter>=<value>).

As for the supported HTTP method, please be sure that GET method is only allowed. And also be sure that it requires HTTP digest authentication along with the administrator privilege for the targeted camera.

How to use freedconfig.cgi

There is the main switch parameter called as "FreeD". It is recommended to enable this parameter to "on" after all the other necessary parameter configurations are done beforehand.

4.2. CGI parameters

This section describes all the Camera Tracking function (free-d) related parameters.

4.2.1. FreeD

This parameter is the main switch whether to enable or disable the PTZF tracking metadata transmission or not.

Parameter	Value	Description
FreeD	"on" / "off" (Default value: "off")	Whether to enable or disable the function

4.2.2. FreeDCameraID

This parameter specifies Camera ID value which is to be put into byte1 (<CA>) of the free-d D0 message.

Parameter	Value	Description

FreeDCameraID	up to 0 - 255 (Default value: “255”)	Specifies free-d Camera ID (<CA>) in decimal form

4.2.3. FreeDTransferMode

This parameter specifies the stream mode (either “always” or “ondemand”). For the details, see in 2.2.1 and 2.2.2.

Parameter	Value	Description
FreeDTransferMode	“always” / “ondemand” (Default value: “always”)	Specifies which stream mode is selected

4.2.4. FreeDUdpPort

In case of “always” mode, this parameter is used as the remote UDP port number of the free-d client end. On the other hand, in case of “ondemand” mode, this parameter is used as the camera’s UDP port number where it waits for the free-d client D0 ‘Start stream mode’ request.

Parameter	Value	Description
FreeDUdpPort	up to 1025 - 65534 (Default value: 40000)	Specifies the UDP port number of either remote or source(camera) end depending on the FreeDTransferMode

4.2.5. FreeDDestinationIP

This parameter will be used only in case of “always” mode. This parameter specifies the remote address of the free-d client which is supposed to receive the metadata stream.

Parameter	Value	Description
FreeDDestinationIP	Valid IPv4 address string (Default: empty)	Specifies the remote address of the free-d client in case of “always” mode

5. Video format and PTZF tracking metadata transmission interval

In this chapter, some details of the PTZF tracking metadata transmission depending on selected video format is explained.

Video format of the equipped LINE OUT, MONITORING OUT can be selected using the SYSTEM SELECT switch in the rear panel of the camera. See the following table in terms of the video format depending on the switch. Please be sure that it will require recycling the power in order to reflect the SYSTEM SELECT switch setting whenever changed.

Figure 1: SYSTEM SELECT switch

Table 5: SYSTEM SELECT switch, video format and PTZF tracking metadata transmission interval (BRC-X1000 series)

No	Video format			PTZF tracking metadata transmission interval [msec]
	BRC-X1000	BRC-H800	BRC-H780	
0	3840x2160/29.97P	Undefined	Undefined	33.36
1	1920x1080/59.94P	1920x1080/59.94P	1920x1080/59.94P	16.68
2	1920x1080/59.94I	1920x1080/59.94I	1920x1080/59.94I	16.68
3	Undefined	Undefined	Undefined	-

4	1280x720/59.94P	1280x720/59.94P	1280x720/59.94P	16.68
5	Undefined	Undefined	Undefined	-
6	Undefined	Undefined	Undefined	-
7	1280x720/59.94P	1280x720/59.94P	1280x720/59.94P	16.68
8	3840x2160/25P	Undefined	Undefined	40.00
9	1920x1080/50P	1920x1080/50P	1920x1080/50P	20.00
A	1920x1080/50I	1920x1080/50I	1920x1080/50I	20.00
B	Undefined	Undefined	Undefined	-
C	1280x720/50P	1280x720/50P	1280x720/50P	20.00
D	Undefined	Undefined	Undefined	-
E	3840x2160/23.98P	Undefined	Undefined	41.70
F	1920x1080/23.98P	1920x1080/23.98P	Undefined	41.70

Table 6: SYSTEM SELECT switch, video format and PTZF tracking metadata transmission interval (BRC-X400 series)

No	Video format	PTZF tracking metadata transmission interval [msec]
0	3840x2160/29.97P	33.36
1	1920x1080/59.94P	16.68
2	1920x1080/59.94I	16.68
3	1920x1080/29.97P	33.36
4	1280x720/59.94P	16.68

5	Undefined	-
6	<command mode>	-
7	1280x720/59.94P	16.68
8	3840x2160/25P	40.00
9	1920x1080/50P	20.00
A	1920x1080/50I	20.00
B	1920x1080/25P	40.00
C	1280x720/50P	20.00
D	Undefined	-
E	3840x2160/23.98P	41.70
F	1920x1080/23.98P	41.70

Please be sure that <command mode> is a mode that the video format is determined by command which is via either HTTP CGI or VISCA protocol.

6. Known limitations

In this chapter, some known limitations are listed and explained below.

6.1. Number of destinations that the PTZF tracking metadata is transmitted to

The number of destinations that the PTZF tracking metadata is transmitted to is limited by 1 client. Even in case that the stream mode is set to “ondemand”, when the subsequent D0 stream start request is received by the camera, its PTZF tracking metadata is changed to the latter client and then the tracking data transmission to the earlier client will be stopped.

6.2. PTZF tracking metadata transmission under the External Sync state

When you put the External Sync signal into the equipped External Sync connector, please be sure that the PTZF tracking metadata transmission may not be delivered when it is under sync state. After completing the external sync, the PTZF tracking metadata resumes to be transferred.

6.3. Zoom tracking metadata as a result of Tele Convert operation

There are several models that support Tele Convert function where it provides with e.g. 2K resolution of the center part of 4K resolution and then output it as 2K video. Although you will be able to use the function depending on the model and its output mode (video format), please be mindful that this operation doesn’t have any effect on the Zoom tracking metadata. If it is planned to use the Tele Convert operation in conjunction with the PTZF tracking metadata transmission, the backend solution would need to take that into consideration.

6.4. Simultaneous use of audio/video streaming and PTZF tracking metadata transmission

BRC-X400 series also support audio/video streaming over network, which would require considerable amount of network bandwidth and processing. Please be mindful that doing audio/video streaming should have some impact on how the PTZF tracking metadata is transferred in a timely manner.

Furthermore, minimizing the processing impact caused by running audio and video codec is

recommended for a stable PTZF tracking metadata transmission. It is recommended to follow the settings below.

- Image 1 video codec setting
  - Size 1: 640x360 (minimum size)
  - Frame rate 1: 5 fps (minimum frame rate)
  - Bit rate compression mode: CBR
  - Bit rate 1: 512 kbps
- Image 2 video codec setting
  - Codec 2: Off
- Image 3 video codec setting
  - Codec 3: Off
- Audio setting
  - Send – Enable: Unchecked

6.5. Tracking metadata delay between BRC-X400 series and BRC-X1000 series

Please be mindful that the tracking metadata output of BRC-X400 has approximately another 1 frame delay than the one of BRC-X1000 for system optimization purpose.

Revision History

Date	Revision	Description
31st/Jul, 2020	1.0	First release.

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