ArduCAM USB Camera C/C++ SDK

User Guide

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Table of Contents

1 Introduction

This user guide describes the detail software operation of ArduCAM USB camera shield based on SDK library. The latest SDK library and examples can be downloaded from the https://github.com/arducam.

2 USB SDK Library

The ArdCAM USB SDK library is designed for both ArduCAM USB2.0 and USB3.0 camera boards. It is binary from library which composed by *.lib and *.dll or *.so files. The x86 is compiled for 32bit system and the x64 is compiled for 64bit system.

3 Demo Code

The demo code is provided in source code form to help user to understand the operation the ArduCAM USB camera and C/C++ SDK library. The demo code located in Cpp folder which is based on OpenCV.

For Windows there is another GUI source project provided which is created with Microsoft Visual Studio 2008 and based on MFC framework, the main files are described as follows.

3.1 Thread.cpp

The Thread.cpp is used to create different tasks to polling the hardware when data is ready to receive and process. Four main tasks should be created to avoid data loss on the hardware side.

_FrameCaptureThread : the thread is used to receive the image data from the camera board.

_FrameReadThread: the thread to read image data from the SDK library frame buffer.

3.2 USBTestDlg.cpp

The USBTestDlg.cpp is used to handle GUI operation of the demo project. It handles the button click actions, register read/write access, RAW to RGB image processing, display real time video and etc.

3.3 CommonTools.cpp

The CommonTools.cpp is used to provide several common functions, such as conversion between number and ASCII code, the creation of file name and etc.

4 ArduCAM APIs

There are a set of API functions that access to the ArduCAM USB camera hardware.

4.1 Data Structures

There is important data structures used by the SDK library for the camera configuration.

4.1.1 ArduCamCfg Data Structure Members

u32CameraType:	unsigned long, reserved for future use.
u32Height:	unsigned long, the height of the video stream
u32Width:	unsigned long, the width of the video stream
u8PixelBytes:	unsigned char, the number of bytes of one pixel
u8PixelBits:	unsigned char, the bits depth per pixel
emI2cMode:	enum type i2c_mode, I2C protocol for the sensor
u32I2cAddr:	unsigned long, I2C slave address for the sensor
u16Vid:	unsigned short, the vendor code of the camera
usbType:	unsigned char, USB camera version

emImageFmtMode: enum type format_mode,Image format

u32Size: unsigned long, The size of the received data, mainly used for JPG data

Definition:

```
typedef struct
{
        Uint32    u32CameraType;
        Uint16    u16Vid;
        Uint32    u32Width;
        Uint32    u32Height;
        Uint8     u8PixelBytes;
        Uint8     u8PixelBits;
        Uint32    u32I2cAddr;
        Uint32    u32Size;
        Uint8     usbType;
        i2c_mode emI2cMode;
        format_mode emImageFmtMode;
        Uint32    u32TransLvl;
}ArduCamCfg;
```

The SDK library support 4 different I2C modes. For example I2C_MODE_8_8 is for 8bits register and 8bits register value, I2C_MODE_8_16 is for 8bits register and 16bits register value.

```
typedef enum   {
        I2C_MODE_8_8      = 0,
        I2C_MODE_8_16     = 1,
        I2C_MODE_16_8     = 2,
        I2C_MODE_16_16    = 3
}i2c_mode;
```

The SDK library support 7 different Image format modes.

```
typedef enum{
        FORMAT_MODE_RAW = 0,
        FORMAT_MODE_RGB = 1,
        FORMAT_MODE_YUV = 2,
        FORMAT_MODE_JPG = 3,
        FORMAT_MODE_MON = 4,
        FORMAT_MODE_RAW_D = 5,
        FORMAT_MODE_MON_D = 6,
}format_mode;
```

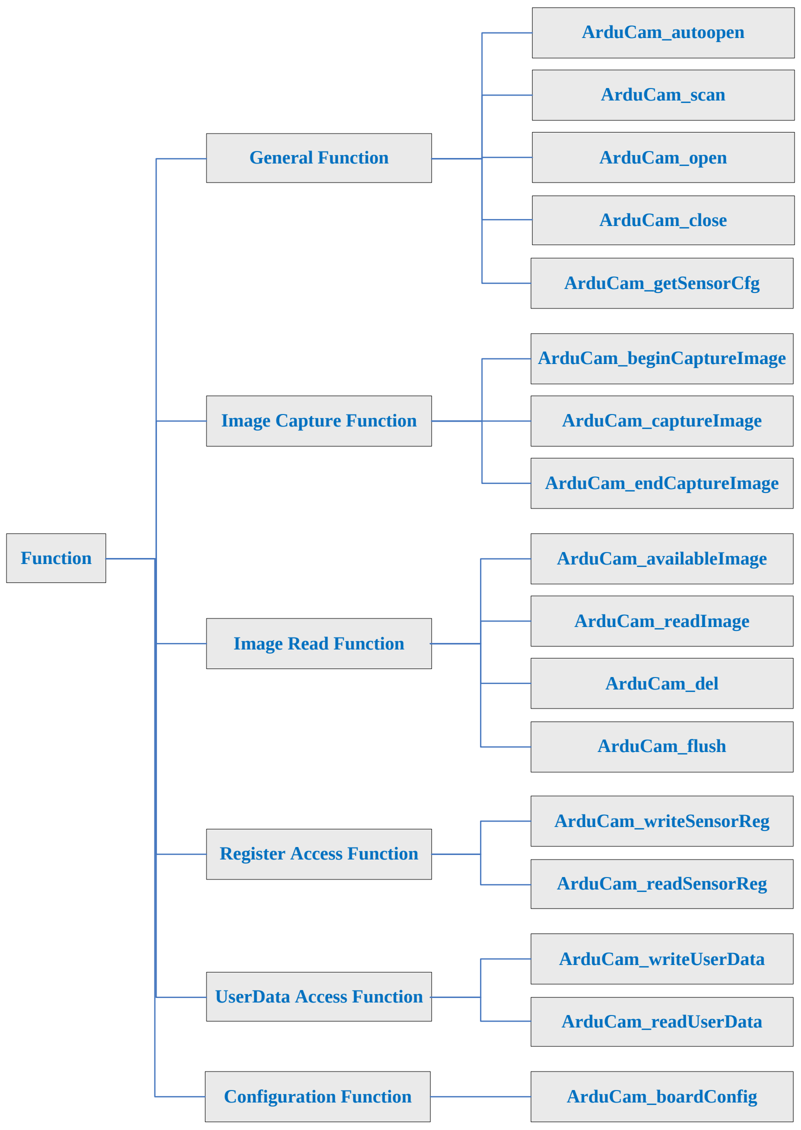
4.1.2 ArduCamIndexinfo Data Structure Members

u8UsbIndex:	Uint8, USB interface index
u8SerialNum[16]:	Uint8[], USB camera serial number

The ArduCamIndexinfo data structure is useful when multiple cameras connected, it helps to find the corresponding camera with index and serial number.

4.2 Function

Function diagram:



4.2.1 General Function

4.2.1.1 unsigned int ArduCam_autoopen(ArduCamHandle &useHandle, ArduCamCfg* useCfg)

This function is used auto open the supported cameras when it find the first camera on the USB bus, which matched the vendor code of the camera in ArduCamCfg structure.

Param 1: handle to the USB camera instance

Param 2: ArduCamCfg structure instance

Return vale: error code

4.2.1.2 unsigned int ArduCam_scan(ArduCamIndexinfo* pstUsbIdxArray)

Scan how many supported cameras available on the USB bus, and record the camera index and camera serial number in Param 1.

Param 1: list of the supported ArduCAM USB camera

Return vale: number of supported cameras

4.2.1.3 unsigned int ArduCam_open(ArduCamHandle &useHandle, ArduCamCfg* useCfg, unsigned long usbIdx)

It is commonly used with scan method and open the camera with the camera index.

Param 1: handle to the USB camera instance

Param 2: ArduCamCfg structure instance

Param 3: index of the camera

Return vale: error code

4.2.1.4 unsigned int ArduCam_close(ArduCamHandle useHandle);

Close the current camera by the camera handle.

Param 1: handle to the USB camera instance

Return vale: error code

4.2.1.5 unsigned int ArduCam_getSensorCfg(ArduCamHandle useHandle, ArduCamCfg* useCfg);

Get the configuration parameter of the USB camera instance.

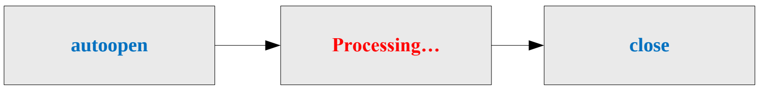
Param1: handle to the USB camera instance

Param1: pointer of configuration parameter structure

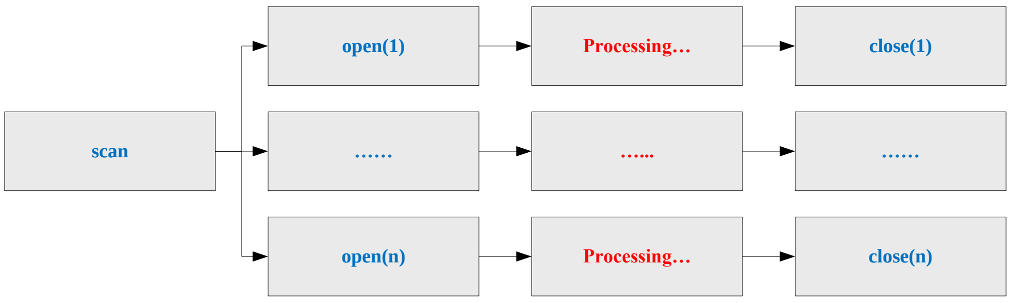
Return value: error code

4.2.1.6 Recommend Operation Procedure

Single Camera：



Multiple Cameras：



4.2.2 Image Capture Function

4.2.2.1 unsigned int ArduCam_beginCaptureImage(ArduCamHandle useHandle)

Create and prepare the image capture task list.

Param 1: handle to the USB camera instance

Return value: error code

4.2.2.2 unsigned int ArduCam_captureImage(ArduCamHandle useHandle)

Launch an image capture task.

Param 1: handle to the USB camera instance

Return value: error code

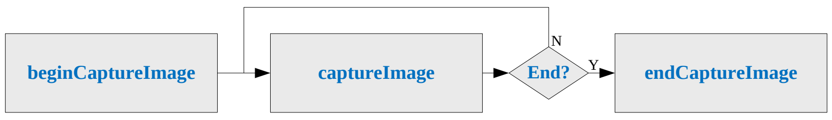
4.2.2.3 unsigned int ArduCam_endCaptureImage(ArduCamHandle useHandle)

Destroy the image capture task list.

Param 1: handle to the USB camera instance

Return value: error code

4.2.2.4 Recommend Operation Procedure



4.2.3 Image Read Function

4.2.3.1 unsigned int ArduCam_availableImage(ArduCamHandle useHandle)

Check if the image is available for reading in image FIFO.

Param 1: handle to the USB camera instance

Return value: error code

4.2.3.2 unsigned int ArduCam_readImage(ArduCamHandle useHandle, unsigned char* &pu8FrameData)

Read one image data from image FIFO.

Param 1: handle to the USB camera instance

Param 2: image data pointer

Return value: error code

4.2.3.3 unsigned int ArduCam_del(ArduCamHandle useHandle)

Delete the image data from image FIFO.

Param1: handle to the USB camera instance

Return value: error code

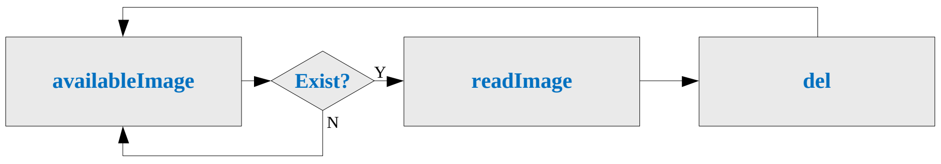
4.2.3.4 unsigned int ArduCam_flush(ArduCamHandle useHandle)

Clear all the image data from image FIFO.

Param1: handle to the USB camera instance

Return value: error code

4.2.3.5 Recommend Operation Procedure



4.2.4 Sensor Register Access Function

4.2.4.1 unsigned int ArduCam_writeSensorReg(ArduCamHandle useHandle, unsigned long regAddr, unsigned long val)

Write the sensor register.

Param 1: handle to the USB camera instance

Param 2: the register address to be written

Param 3: value to be written

Return value: error code

4.2.4.2 unsigned int ArduCam_readSensorReg(ArduCamHandle useHandle, unsigned long regAddr, unsigned long* pval)

Read the sensor register.

Param 1: handle to the USB camera instance

Param 2: the register address to be read

Param 3: read value

Return value: error code

4.2.5 User Data Access Function

There are 1024 bytes flash memory for storing user defined data.

4.2.5.1 unsigned int ArduCam_writeUserData(ArduCamHandle useHandle, unsigned short u16Addr, unsigned char u8Len, unsigned char* pu8Data);

Write data to user region.

Param 1: handle to the USB camera instance

Param 2: user region address to be written, range from 0 ~1023.

Param 3: data length to be written (length≤32，address+length≤1024)

Param 4: data pointer to be written

Return value: error code

4.2.5.2 unsigned int ArduCam_readUserData(ArduCamHandle useHandle, unsigned short u16Addr, unsigned char u8Len, unsigned char* pu8Data)

Write data from user region.

Param 1: handle to the USB camera instance

Param 2: user region address to be read, range from 0 ~1023.

Param 3: data length to be read (length≤32，address+length≤1024)

Param 4: data pointer for read data.

Return value: error code

4.2.6 Camera Board Configuration

The board configuration function is used to set correct register or firmware values to hardware for different working mode. See section 5 for detail.

4.2.6.1 unsigned int ArduCam_setboardConfig(ArduCamHandle useHandle, unsigned char u8Command, unsigned short u16Value, unsigned short u16Index, unsigned int u32BufSize, unsigned char*pu8Buf)

Write board configuration data.

Param 1: handle to the USB camera instance

Param 2: vendor command code

Param 3: vendor command value

Param 4: vendor command index

Param 5: data buffer size

Param 6: data buffer pointer

Return value: error code

4.2.7 External Trigger

The external trigger mode requires latest hardware and firmware support. If the firmware version does not support external triggering, the following function will return: USB_BOARD_FW_VERSION_NOT_SUPPORT_ERROR

4.2.7.1 unsigned int ArduCam_setMode(ArduCamHandle handle,int mode)

This function is used to set the working mode between external trigger mode and continuous mode.

Param 1: handle to the USB camera instance

Param 2: mode EXTERNAL_TRIGGER_MODE or CONTINUOUS_MODE

Return value: error code

4.2.7.2 unsigned int ArduCam_isFrameReady(ArduCamHandle handle)

This function checks if there is a frame ready to read.

Param 1: handle to the USB camera instance

Return value: 1 is ready or 0 is not ready

4.2.7.3 unsigned int ArduCam_softTrigger(ArduCamHandle handle)

This function is used to trigger the camera to take image by software rather than from the external trigger input.Param 1: handle to the USB camera instance

Return value: error code

4.2.7.4 unsigned int ArduCam_getSingleFrame(ArduCamHandle handle,int time_out=1500)

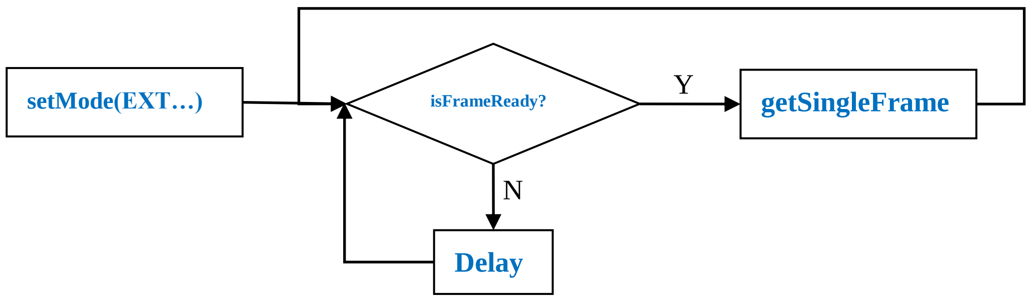
This method can be used to read a single frame using software or external hardware trigger.

Param 1: handle to the USB camera instance

Param 2: Timeout millisecond default is 1500ms

Return value: error code

4.2.7.5 Recommend Operation Procedure



5 Vendor Command Code

The vendor command code is used to configure the hardware or firmware registers. The USB2.0 and USB3.0 vendor command code lists as below:

5.1 USB2.0 Vendor Command Code

VRCMD Code	Value	Index	Size	Buffer Value	Comment
0xD7	0x4600	0x0100	1	0x00	Reset the camera
0xD7	0x4600	0x0100	1	0x15	Enable IR-Cut
0xD7	0x4600	0x0100	1	0x25	Invert the Pixel Clock
0xD7	0x4600	0x0100	1	0x45	Enable JPEG mode
0xD7	0x4600	0x0100	1	0x85	16bit camera bus
0xF6	0x0000	0x0000	3	0x03,0x04,0x0C	Sync 8bit bus mode
0xF6	0x0000	0x0000	3	0xCB,0x00,0x0C	Async 8bit bus mode
0xF6	0x0000	0x0000	3	0x03, 0x04, 0x09	Sync 16bit bus mode

5.2 USB3.0 Vendor Command Code

VRCMD Code	Value	Index	Size	Buffer Value	Comment
0xA3	0x0000	0x0000	0	NULL	Reset the camera
0xA3	0x8000	0x0000	0	NULL	Disable IR-Cut
0xA3	0x8001	0x0000	0	NULL	Enable IR-Cut
0xF3	0x0000	0x0000	0	NULL	Enable I2C bus
0xF9	0x0000	0x0000	0	NULL	8bit camera bus
0xF9	0x0001	0x0000	0	NULL	16bit camera bus

6 Error Code

The error code of the SDK library is defined in the following table.

```
#define   USB_CAMERA_NO_ERROR                          0x0000
#define   USB_CAMERA_USB_CREATE_ERROR                  0xFF01
#define   USB_CAMERA_USB_SET_CONTEXT_ERROR             0xFF02
#define   USB_CAMERA_VR_COMMAND_ERROR                  0xFF03
#define   USB_CAMERA_USB_VERSION_ERROR                 0xFF04
#define   USB_CAMERA_BUFFER_ERROR                      0xFF05
#define   USB_CAMERA_I2C_BIT_ERROR                     0xFF0B
#define   USB_CAMERA_I2C_NACK_ERROR                    0xFF0C
#define   USB_CAMERA_I2C_TIMEOUT                       0xFF0D
#define   USB_CAMERA_USB_TASK_ERROR                    0xFF20
#define   USB_CAMERA_DATA_OVERFLOW_ERROR               0xFF21
#define   USB_CAMERA_DATA_LACK_ERROR                   0xFF22
#define   USB_CAMERA_FIFO_FULL_ERROR                   0xFF23
#define   USB_CAMERA_DATA_LEN_ERROR                    0xFF24
#define   USB_CAMERA_FRAME_INDEX_ERROR                 0xFF25
#define   USB_CAMERA_USB_TIMEOUT_ERROR                 0xFF26
#define   USB_CAMERA_READ_EMPTY_ERROR                  0xFF30
#define   USB_CAMERA_DEL_EMPTY_ERROR                   0xFF31
#define   USB_CAMERA_SIZE_EXCEED_ERROR                 0xFF51
#define   USB_USERDATA_ADDR_ERROR                      0xFF61
#define   USB_USERDATA_LEN_ERROR                       0xFF62
#define   USB_BOARD_FW_VERSION_NOT_SUPPORT_ERROR   0xFF71
```