

C++ programming example for Visionary-T cameras

Requirements

The sample contains a Visual Studio Solution file as well as a CMakeLists file. To open and compile it with Microsoft Visual Studio at least Version of 2010 is needed. For platform independent compiling the CMakeLists is available, which needs at least CMake 2.8.

Quickstart

Using Visual studio

1. Open the SampleVisionaryT.sln file with Visual Studio
2. Set The SampleVisionaryT for your device type as StartUp project
3. Start the debugger and the sample will automatically connect to a Visionary-T camera with default IP (**192.168.1.10**) and default API-Port (**2114**). To change them modify the function call to **runStreamingDemo()** in the main function.

Using CMake

1. Run CMake on the CMakeLists file.
2. This should end with an executable for your platform.
3. Start the debugger and the sample will automatically connect to a Visionary-T camera with default IP (**192.168.1.10**) and default API-Port (**2114**). To change them modify the function call to **runStreamingDemo()** in the main function.

Code examples

This section covers the different parts of the sample in more detail and how to adjust them to work for your own applications.

Connecting to a device

The first step is to initialize a data handler, a data stream, and a camera control object, the **ipAddress** (default **192.168.1.10**) and **port** (default **2114**) variables specifies which device to connect to:

```
#include <boost/shared_ptr.hpp>
#include <boost/make_shared.hpp>
#include "VisionaryTData.h"
#include "VisionaryDataStream.h"
#include "VisionaryControl.h"
[...]
```

```
boost::shared_ptr<VisionaryTData> pDataHandler =  
boost::make_shared<VisionaryTData>();  
VisionaryDataStream dataStream(pDataHandler, inet_addr(ipAddress),  
htons(port));  
VisionaryControl control(inet_addr(ipAddress), htons(2112));
```

The next step is to open both the data stream and control connections, they both return a **bool** specifying if the connection was successful or not:

```
if (!dataStream.openConnection())  
{  
    // Data stream connection failed  
}  
if (!control.openConnection())  
{  
    // Data control (CoLaB) connection failed  
}
```

There is now a connection established to the device and it is possible to start communicating with it. When you no longer wish to communicate with the device it is important to close both connections:

```
control.closeConnection();  
dataStream.closeConnection();
```

Capturing a single frame

The camera will by default be in Manual mode, meaning no frames will be captured unless requested using the control connection:

```
if(!control.stepAcquisition())  
{  
    // Failed to request next frame  
}
```

It is then possible to use the data stream connection to get next frame. The received frame will then be accessible via the data handler which was provided to the data stream object:

```
if (dataStream.getNextFrame())  
{  
    int width = pDataHandler->getWidth(); // Image width  
    int height = pDataHandler->getHeight(); // Image height  
    uint32_t frameNumber = pDataHandler->getFrameNum(); // Frame number  
    uint64_t timestamp = pDataHandler->getTimestampMS(); // Frame timestamp in  
    milliseconds  
    const std::vector<uint16_t> distanceMap = pDataHandler->getDistanceMap();  
    // Distance values  
    const std::vector<uint16_t> intensityMap = pDataHandler->  
    >getIntensityMap(); // Intensity values
```

```
const std::vector<uint16_t> confidenceMap =  
    pDataHandler->getConfidenceMap(); // Confidence values  
}
```

Continuous frame acquisition

To get a continuous stream of frames, first set the camera to Continuous mode and use the data stream object to get as many frames as required:

```
control.startAcquisition();  
for (int i = 0; i < 100; i++)  
{  
    if (dataStream.getNextFrame())  
    {  
        printf("Frame received in continuous mode, frame #%d \n",  
            pDataHandler->getFrameNum());  
    }  
}
```

Once all required frames are received it is recommended to set the camera in Manual mode again:

```
control.stopAcquisition();
```

Creating a 3D point cloud

Every received frame contains all required data to calculate a 3D point cloud. A point cloud is a list of 3D coordinates. The data handler contains a convenience method which converts the latest received frame to a point cloud:

```
#include "PointXYZ.h"  
[...]  
if (dataStream.getNextFrame())  
{  
    std::vector<PointXYZ> pointCloud;  
    pDataHandler->generatePointCloud(pointCloud);  
}
```

For increased performance the data handler internally caches some of the calculations and reuses this for the next frames.

Saving the point cloud to a PLY file

The C++ sample code also contains a convenience method for writing a point cloud to a [PLY \(Polygon File Format\)](#) file:

```
#include "PointCloudPlyWriter.h"  
[...]  
PointCloudPlyWriter::WriteFormatPLY(  

```

```
"MyPointCloud.ply",           // File to write to
pointCloud,                   // The list of 3D positions
pDataHandler->getIntensityMap(), // The list of intensities (optional)
true);                        // Enable binary
```

The method supports writing both ASCII and Binary PLY files, and is controlled by the last parameter. Binary is recommended as it is much faster to write, and significantly reduces the file size.

The intensity values parameter can be omitted if your application doesn't need them.

Device configuration

It is also possible to both read and write the device configuration variables using C++. This is done by sending and receiving CoLaB commands to and from the device. When reading or writing variables, or invoking a device method the general approach is:

1. Create a CoLaB command
2. Send the created command to the device
3. Receive the response command from the device
4. Parse the response command

A CoLaB command is made up of a **type**, a **name**, and any number of parameters. The name and which parameters to use for a specific command is specified in the *SOPAS Communication Interface Description* document.

Reading a variable

The goal in this example is to read the **integrationTimeUs** variable from the device. The first step is to find the variable in the *SOPAS Communication Interface Description* document, and go to the *Variable Telegram Syntax* part, for **integrationTimeUs** the first table (*Read Variable*;) looks like this:

Read Variable:				
sRN integrationTimeUs				
Telegram Part	Telegram	Type	Length [Byte]	Description
Command Type	sRN	String	3	Read SOPAS Variable by Name
Command	integrationTimeUs	String	17	The integration time of the 3D frontend.

This specifies that to read the variable a CoLaB command must be constructed with the name **integrationTimeUs** (**Note:** this might not always match the variable name!) and no additional parameters.

The easiest way to create such a command is to use the **CoLaBCommandBuilder**:

```
#include "CoLaCommandType.h"
#include "CoLaBCommand.h"
#include "CoLaBCommandBuilder.h"
[...]
```

```
CoLaBCommand getIntegrationTimeCommand =
CoLaBCommandBuilder(CoLaCommandType::READ_VARIABLE,
"integrationTimeUs").build();
```

The next step is to send the command to the device, and receive the response:

```
CoLaBCommand integrationTimeResponse =
control.sendCommand(getIntegrationTimeCommand);
```

To be able to parse the response command it is again required to consult the *SOPAS Communication Interface Description* document to see what the response contains. This time look for the table *Read Variable Response*; which for the `integrationTimeUs` variable looks like this:

Read Variable Response:				
sRA integrationTimeUs <data>				
Telegram Part	Telegram	Type	Length [Byte]	Description
Command Type	sRA	String	3	SOPAS Variable Read Acknowledge
Command	integrationTimeUs	String	17	The integration time of the 3D frontend.
Variable Data	data	UDInt	4	

The important part from this table is the *Variable Data* entry which specifies that the response contains a single value of type `UDInt` (Unsigned Double Integer). This knowledge can then be used together with a `CoLaBCommandReader` to read the actual value.

```
#include "CoLaBCommandReader.h"
[...]
uint32_t integrationTimeUs =
CoLaBCommandReader(integrationTimeResponse).readUDInt();
```

Authorization

Most variables can be read without any specific permission, but writing them often requires a login to be performed first. In the *SOPAS Communication Interface Description* document the required access level for variables are specified in the "Variable Overview" table, and for the `integrationTimeUs` variable looks like this:

Read-Access	Always
Write-Access	AuthorizedClient, Service

Before writing to a variable one of the specified *Write-Access* levels must be set, this can be done using CoLaB commands as well, but the control object has a convenience method for this, the first parameter is the requested access level, and the second parameter is the password for that level:

```
if (control.login(CoLaUserLevel::AUTHORIZED_CLIENT, "CLIENT"))
{
    // Login was successful
}
```

The method returns a `bool` specifying whether the login attempt was successful or not. After finishing writing all variables it is recommended to logout:

```
control.logout();
```

Writing a variable

The steps to write a variable are very similar to reading a variable. The first step is to find the *Write Variable*: table for the variable, in this case for `integrationTimeUs`:

Write Variable:				
sWN integrationTimeUs <data>				
Telegram Part	Telegram	Type	Length [Byte]	Description
Command Type	sWN	String	3	Write SOPAS Variable by Name
Command	integrationTimeUs	String	17	The integration time of the 3D frontend.
Variable Data	data	UDInt	4	

As expected, the *Variable Data* parameter here is also a `UDInt`. Again the `CoLaBCommandBuilder` is used to construct the command to send to the device:

```
CoLaBCommand setIntegrationTimeCommand =
CoLaBCommandBuilder(CoLaCommandType::WRITE_VARIABLE,
"integrationTimeUs").parameterUDInt(3800).build();
```

Compared to reading the variable the type is now set to `WRITE_VARIABLE`, and a `UDInt` parameter is also appended. Because writing a variable doesn't return anything there is no need to parse the result, but it is recommended to check for errors (see next section).

Error handling

When reading and writing variables in a real application it is recommended to check the response for errors:

```
#include "CoLaError.h"
[...]
CoLaBCommand getIntegrationTimeResponse =
control.sendCommand(CoLaBCommandBuilder(CoLaCommandType::READ_VARIABLE,
"integrationTimeUs").build());
if (getIntegrationTimeResponse.getError() == CoLaError::OK)
{
    // Command was successful
}
else
{
    // There was an error when executing the command.
}
```

Reading struct and array variables

So far the variable has only had a single value but variables can actually contain either a struct of multiple values, an array of values, or even an array of structs. This example will show how to

read the variable **EMsgInfo** which contains all info log messages in the device. Again the first step is to look up the variable definition, this is the *Variable Overview*:

Variable Name	Description
EMsgInfo	Info messages which are stored in volatile memory. They are informations and do not indicate an error condition.

Communication Name	MSinfo
Sopas Synchronisation	Variable is not relevant for synchronisation with SOPAS ET.
Sopas Index	19
Read-Access	Always
Write-Access	No! (readonly)

Array	
Length	25
UserType	
ErrStructType	See the chapter "User Types" for details.

There are a few important things to notice here:

- The *Communication Name* does not match the variable name.
- The *Write-Access* is *No!* which means the variable can not be written to.
- The data is an **Array** of **ErrStructType** elements.
- The array always contains 25 items.

As a first step construct a read command and send it to the device, notice that the *Communication Name* is used and not the variable name:

```
CoLaBCommand getMessagesCommand =
CoLaBCommandBuilder(CoLaCommandType::READ_VARIABLE, "MSinfo").build();
CoLaBCommand messagesResponse = control.sendCommand(getMessagesCommand);
```

The next step is to parse the response. For this it is required to lookup the **ErrStructType** definition in the *SOPAS Communication Interface Description* document, which looks like this:

Struct	
ErrorId	
UDInt	
Value Range	0..4294967295
ErrorState	
UDInt	
Value Range	0..4294967295
FirstTime	
UserType	
ErrTimeType	See the chapter "User Types" for details.
LastTime	
UserType	
ErrTimeType	See the chapter "User Types" for details.
NumberOccurance	
UInt	
Value Range	0..65535
Initialisation	0
ErrReserved	
UInt	
Value Range	0..65535
Initialisation	0
ExtInfo	
FlexString	
Length	0..50

As seen above this struct contains seven different values with different types. Also notices that the **FirstTime** and **LastTime** members are of type **ErrTimeType**, this struct can also be found in the document:

Struct	
PwrOnCnt	
UInt	
Value Range	0..65535
Initialisation	0
OpSecs	
UDInt	
Value Range	0..4294967295
Initialisation	0
TimeOccur	
UDInt	
Value Range	0..4294967295
Initialisation	0

Together with the knowledge that the array always contains 25 items it is now possible to parse the response command using a **CoLaBCommandReader**:

```
CoLaBCommandReader reader(messagesResponse);
for (int i = 0; i < 25; i++) // Read 25 items
{
    uint32_t errorId = reader.readUDInt();
    uint32_t errorState = reader.readUDInt();
}
```



```
// Read ErrTimeType struct members for FirstTime
uint16_t firstTime_PwrOnCount = reader.readUInt();
uint32_t firstTime_OpSecs = reader.readUDInt();
uint32_t firstTime_TimeOccur = reader.readUDInt();

// Read ErrTimeType struct members for LastTime
uint16_t lastTime_PwrOnCount = reader.readUInt();
uint32_t lastTime_OpSecs = reader.readUDInt();
uint32_t lastTime_TimeOccur = reader.readUDInt();

uint16_t numberOccurance = reader.readUInt();
uint16_t errReserved = reader.readUInt();
std::string extInfo = reader.readFlexString();

// Write all non-empty info messages to the console
if (errorId != 0)
{
    printf("Info message [0x%032x], extInfo: %s, numberOccurance: %d\n",
           errorId, extInfo.c_str(), numberOccurance);
}
}
```

Note: It is important to read the values in the same order as they appear in the table!
Use `reader.rewind();` to read from the beginning of a command again.

Support

For questions about the C++ sample contact:

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